

# **NEW JERSEY SHORE PROTECTION MASTER PLAN**



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STATE OF NEW JERSEY  
DEPARTMENT OF ENVIRONMENTAL PROTECTION  
DIVISION OF COASTAL RESOURCES

OCTOBER 1981

**VOLUME I - THE PLAN**

# NEW JERSEY SHORE PROTECTION MASTER PLAN

## VOLUME 1

### THE PLAN

OCTOBER 1981

State of New Jersey

Brendan Byrne  
Governor

U. S. DEPARTMENT OF COMMERCE NOAA  
COASTAL SERVICES CENTER  
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Department of Environmental Protection  
Jerry Fitzgerald English  
Commissioner

Division of Coastal Resources  
David N. Kinsey  
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Prepared With The Assistance Of:

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6 Commerce Drive  
Cranford, New Jersey 07016

Contract Number DBC-P168  
Job Number 2422-013-10

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STATE OF NEW JERSEY  
DEPARTMENT OF ENVIRONMENTAL PROTECTION  
OFFICE OF THE COMMISSIONER  
P. O. BOX 1390  
TRENTON, N. J. 08625  
609-292-2885

October 1981

Dear Governor Byrne, Members of the Legislature, and Citizens of  
New Jersey:

The Jersey Shore is many things to many people: a place to live, a place to work and a place to visit. Sandy beaches, dunes, wetlands, jetties, fishing and amusement piers, inlets, bays, rivers, vacation houses, year-round residences, hotels, motels, and shops all make up the built and natural environment of the shore.

To protect these vital resources, the Department of Environmental Protection takes pride in presenting the first New Jersey Shore Protection Master Plan. This Plan, now adopted after more than two years of studies, workshops, and hearings, will guide five types of decisions and actions of the Department of Environmental Protection, and in particular the Division of Coastal Resources, to protect the shoreline.

First, the Plan will guide DEP's decisions on financial assistance for the construction, repair and maintenance of beaches, groins, jetties, sea-walls, bulkheads, and dunes, investing prudently and rationally the funds available from the Beaches and Harbors Bond Fund of 1977, future bond issues, and other sources, including local government matching funds and federal reimbursement. Second, the Plan provides the framework for DEP's technical assistance on shore protection matters to local officials, citizens, and developers. Third, the Plan recognizes the important role of existing land use regulation by DEP and local governments in protecting sensitive beaches and dunes from inappropriate development. Fourth, the Plan will help DEP raise public awareness of the fragility of our barrier islands and the risks of coastal development. Fifth, the Plan defines DEP policy and provides the basis for the advocacy of proper management of shoreline processes.

The New Jersey Shore Protection Master Plan is presented in three volumes to facilitate its use. Volume I is the Plan itself. Volume II is the basis and background for the Plan, and contains useful reference materials and discussions of all the alternatives considered in developing the Plan. Volume III presents the public comments on the Draft Plan and the DEP responses to those helpful comments.

Life by the sea is exciting. Over the past 200 years, the people of New Jersey have extensively built up our shoreline. Some of these actions have led to disappearing beaches and property destruction during coastal storms. The Shore Protection Master Plan charts many steps that should be taken in coming years to protect the shoreline by working in closer harmony with the natural forces of the sea.

Sincerely,

  
JERRY FITZGERALD ENGLISH  
Commissioner

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**VOLUME 1**

**THE PLAN**

**OCTOBER 1981**

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## CHAPTER I

### INTRODUCTION AND BACKGROUND

#### A. NEW JERSEY SHORE PROTECTION PROGRAM

New Jersey, like all coastal states, has for decades been involved in providing financial and technical assistance to help shorefront communities cope with shoreline erosion. In the early 1940's, legislation (N.J.S.A. 12:6A-1) authorized the Department of Environmental Protection's predecessor (the Department of Conservation and Economic Development) to repair, reconstruct or construct bulkheads, seawalls, breakwaters, groins, jetties, beaches, dunes and any or all appropriate structures for shore protection purposes. The annual appropriation for this work has averaged approximately one million dollars, and \$49 million in State, Federal, municipal, and county funds were spent between 1959 and 1974.

In recent years, the need for shoreline protection planning has been heightened by the cumulative effect of minor and major storms (particularly the March 1962 storm) and the tremendous boom in oceanfront development. The New Jersey Commission on Capital Budgeting and Planning recognized that the annual one million dollar appropriation for State Aid to municipalities for shore protection purposes was inadequate and in 1977 the voters of the State approved a \$30 million Beaches and Harbors Bond Issue, which provided \$20 million for State Aid for shore protection purposes and \$10 million for harbor cleanup.

Local governments in New Jersey have taken different approaches towards shore protection, with some allowing dunes to be overtaken by development, while others worked to acquire oceanfront lots and rebuild dunes. The Federal government has also been actively involved in shorefront protection through the Army Corps of Engineers, and in shorefront development through the National Flood Insurance Program. The net result of these State, Federal and Local activities has been an amalgam and somewhat reactive approach to shore protection. This Shore Protection Master Plan is intended to represent a more cohesive and comprehensive approach to the problem of shore protection for use by the State, and hopefully other levels of government as well.

The five related components that make up the State's Shore Protection Program are: Financial Assistance, Technical Assistance, Land Use Regulation, Public Awareness, and Program Advocacy.

Financial assistance involves the funding of various approaches and solutions to shoreline protection problems by the Department of Environmental Protection (DEP) and local governments. State aid is distributed on a cost sharing basis with municipalities and county governments and, depending upon the area selected for protection, Federal reimbursement may be available. Financial assistance by the Army Corps of Engineers would be based on cost sharing between Federal and non-Federal interests. Reimbursement of Federal costs for approved advance construction by the State is part of the existing cooperative agreement and would occur when project construction is initiated. The current funding source for the State's financial assistance is the Beaches and Harbors Bond Fund and the ratio of the State-local share is determined by the Legislature.

DEP's Division of Coastal Resources provides technical assistance on shore protection matters to municipalities, citizens, developers, and others. Assistance

ranges from technical consultation by the Department's coastal engineers, scientists, and planners, to testimony before local governments in order to assist municipal enforcement of ordinances restricting development in sensitive and hazardous areas.

The Division of Coastal Resources engages in direct land use regulation in the administration of three state regulatory programs in the coastal zone: the Coastal Area Facility Review Act (CAFRA), the Wetlands Act, and the Waterfront Development Law. Those laws, however, do not regulate the construction of most individual homes. In fact, up to 25 homes can be built along the shore without DEP approval. This situation, which has been the subject of several proposed pieces of legislation in the last two years, cannot be changed without action by the New Jersey Legislature.

Since many people have not experienced first hand the fury of the sea when a storm hits a barrier island, it has been necessary to raise public awareness of the hazards and risks associated with such development. The Division has worked with citizens, interest groups and various levels of government to increase the general public understanding of the dynamics of barrier islands.

Advocacy of coastal interests and proper management of shoreline processes is another activity in which the Division is involved. It has made grants to municipalities to develop dune protection programs and work with groups and individuals to identify shore protection problems and to advocate possible solutions for consideration by the public. It also comments on Federal actions affecting barrier islands.

The Shore Protection Program embraces these five components and represents the State's effort to properly manage its shorelines, and in particular its barrier islands. The future must see active work to cope with current erosion problems to increase the preparedness for natural disasters and establish, before the next major coastal storm, the actions that will be taken to enable the natural beach and dune system to recover thereafter.

## **B. THE NEW JERSEY APPROACH TO SHORE PROTECTION PLANNING**

### **1. Purpose and Scope of the Shore Protection Master Plan**

The State of New Jersey has been engaged in shore protection activities for decades, as authorized by law (N.J.S.A. 12:6A-1 et seq.). In 1978, the Legislature passed a Beaches and Harbors Bond Act (P.L., 1978, c.157) and called on DEP to prepare a comprehensive Shore Protection Master Plan. In so doing, the Legislature saw the need to reduce the negative impacts of and conflicts between shoreline erosion management and coastal development, reduce hazard losses, and satisfy shore user demands in an equitable way.

The Shore Protection Master Plan was prepared by Dames & Moore under the direction of New Jersey Department of Environmental Protection, Division of Coastal Resources, under contract with the Department of Treasury, Division of Building and Construction. Its purpose is to:

- o Review earlier shore protection plans and studies;
- o Assess the nature of and extent of the erosion problem;
- o Assess the nature of the coastal processes;
- o Review past, present, and evolving State and Federal policies related to shore protection and coastal resources;

- o Provide a comparative evaluation of suitable alternative approaches (engineering and land management) to the mitigation of shore erosion, including consideration of the costs, benefits, environmental implication, and implementation feasibility;
- o Develop a list of priorities among the engineering plans; and
- o Provide a comprehensive shore protection plan which is consistent with State coastal management policies and objectives.

The shore areas affected by the Shore Protection Master Plan include the municipalities listed in Table I.B-1 and the parks and other State and federally-controlled shorelands which are listed in Table I.B-2. The basic shore types in each of the affected areas is also provided in these tables. This study addresses the shore areas which are exposed to significant erosional forces and have had a history of erosion problems. In particular these areas include the Raritan Bay shore from Perth Amboy to Sandy Hook; the Atlantic Ocean shore from Sandy Hook to Cape May Point; the Delaware Bay shore from Cape May Point to Stow Creek; and the Delaware River from Stow Creek to Crosswicks Creek.

## 2. The Reach Concept

Where appropriate, development of the engineering plans for New Jersey is based on a regional (reach) approach, rather than the stop-gap piecemeal solutions of the past. Along ocean shores, piecemeal solutions often tend to aggravate the problem in adjacent shore areas.

The "reach concept" or approach is the method whereby consistent shore protection engineering plans are developed within areas affected by similar coastal processes. The reach concept in the engineering design process endeavors to reduce the potential for any one shore erosion control program to produce adverse effects in adjacent shore areas (e.g., down-drift effects). Shore protection is thereby provided for an entire coastal compartment, irrespective of political subdivision boundaries, rather than for only local erosion problem areas as has been the traditional practice in New Jersey.

As discussed in Section I.C-3, coastal processes interrelationships do exist between major coastal geomorphic zones. However, the major geomorphic zones can be divided into smaller portions (reaches), which reflect a sufficient degree of similarity of processes, to allow development of individual alternative plans for shore protection. The New Jersey shoreline has been divided up into 16 reaches (13 ocean, 2 bay and one river reach) based on an evaluation of natural punctuations in operative coastal processes. The importance of the inlets in punctuating the coastal processes is reflected in the fact that most of the ocean reaches are defined by inlet positions.

The reaches that have been developed for the Master Plan are presented on Figure I.B-1, and in Table I.B-3 together with the affected counties and political subdivisions within each reach. The reaches designated on Table I.B-3 and Figure I.B-1 form the basic, discrete planning units for the alternative shore protection plans presented in Chapter II, as well as the basis for discussions of shore erosion, socioeconomic, and environmental characteristics discussed in this and subsequent chapters.

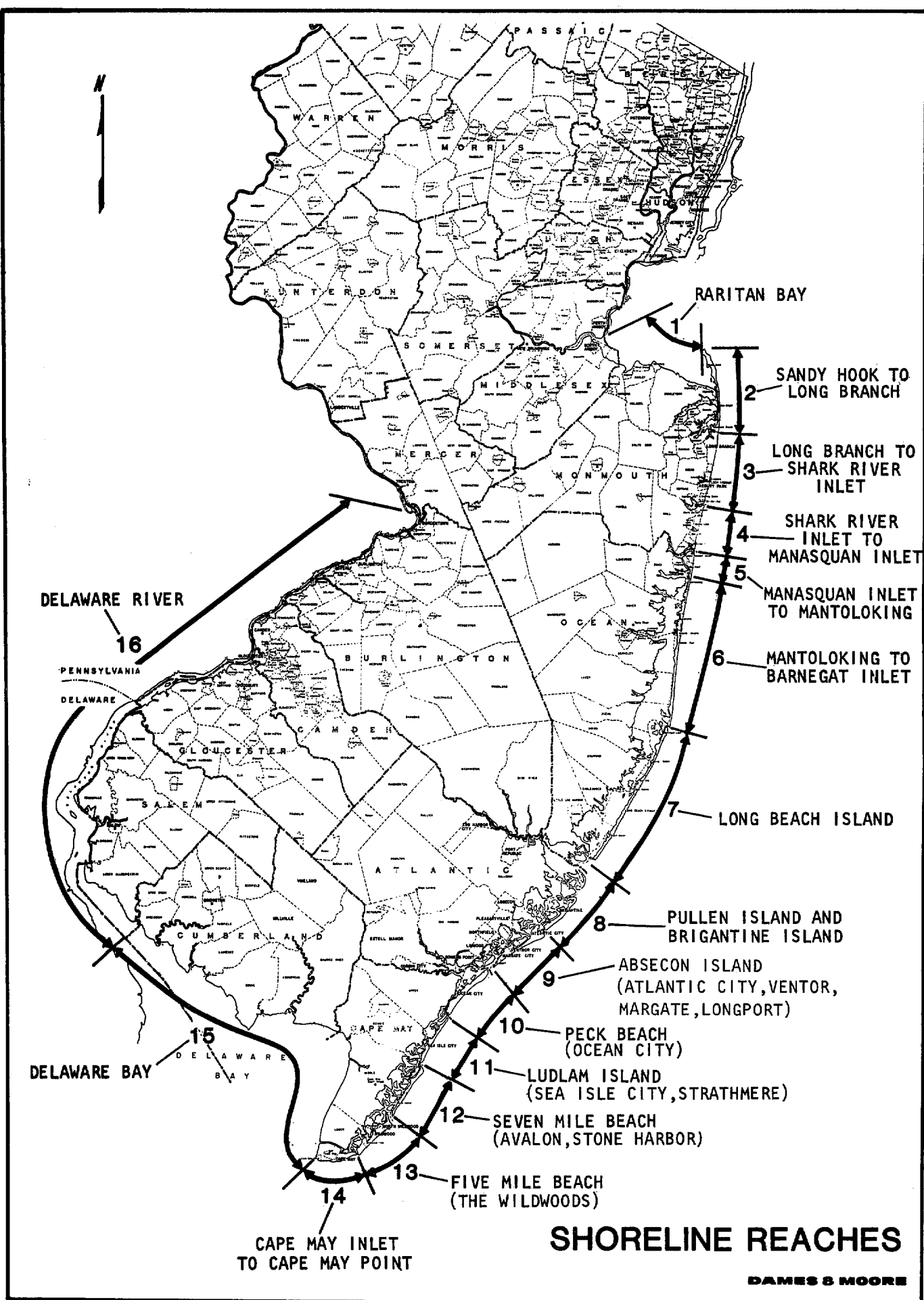


TABLE I.B-1

## MUNICIPALITIES AFFECTED BY THE MASTER PLAN

County/ Political Subdivision	SHORE TYPES				
	Atlantic Ocean	Inlet	Open Bay (Raritan or Delaware Bay)	Backbay, Inland Waterways, Tidal Tributaries	Major Tidal River (Delaware River)
<b>ATLANTIC COUNTY</b>					
*Absecon City	—	—	—	X	—
*Atlantic City	X	X	—	X	—
*Brigantine City	X	X	—	X	—
*Egg Harbor Township	—	—	—	X	—
Estell Manor City	—	—	—	X	—
*Galloway Township	—	—	—	X	—
*Linwood City	—	—	—	X	—
*Longport Borough	X	X	—	X	—
*Margate City	X	—	—	X	—
*Mullica Township	—	—	—	X	—
*Pleasantville City	—	—	—	X	—
Port Republic City	—	—	—	X	—
*Somers Point	—	—	—	X	—
*Ventnor City	X	—	—	X	—
<b>BURLINGTON COUNTY</b>					
Bass River Township	—	—	—	X	—
*Beverly, City of	—	—	—	—	X
*Bordentown City	—	—	—	—	X
*Bordentown Township	—	—	—	—	X
*Burlington City	—	—	—	—	X
*Burlington Township	—	—	—	—	X
*Cinnaminson Township	—	—	—	—	X
*Delanco Township	—	—	—	—	X
Delran Township	—	—	—	—	X
*Edgewater Park Township	—	—	—	—	X
Fieldsboro, Borough	—	—	—	—	X
*Florence Township	—	—	—	—	X
Mansfield Township	—	—	—	—	X
Palmyra Borough	—	—	—	—	X
Riverton Borough	—	—	—	—	X
*Washington Township	—	—	—	X	—
<b>CAMDEN COUNTY</b>					
Camden City	—	—	—	—	X
Gloucester City	—	—	—	—	X
*Pennsauken Township	—	—	—	—	X
<b>CAPE MAY COUNTY</b>					
*Avalon Borough	X	X	—	X	—
*Cape May City	X	—	—	X	—
*Cape May Point Borough	X	—	X	—	—
*Dennis Township	—	—	X	X	—
*Lower Township	X	—	X	X	—
*Middle Township	—	—	X	X	—
*North Wildwood City	X	X	—	X	—
*Ocean City	X	X	—	X	—
*Sea Isle City	X	X	—	X	—
*Stone Harbor Borough	X	X	—	X	—
*Upper Township (Strathmere)	X	X	—	X	—
*West Cape May	—	—	—	X	—
*West Wildwood	—	—	—	X	—
*Wildwood City	X	—	—	X	—
*Wildwood Crest Borough	X	—	—	X	—
<b>CUMBERLAND COUNTY</b>					
*Commercial Township	—	—	X	—	—
*Downe Township	—	—	X	—	—
*Fairfield Township	—	—	X	—	—
*Greenwich Township	—	—	X	—	—
Lawrence Township	—	—	X	—	—
*Maurice River Township	—	—	X	—	—
<b>GLOUCESTER COUNTY</b>					
Greenwich Township	—	—	—	—	X
*Logan Township	—	—	—	—	X
*National Park Borough	—	—	—	—	X
*Paulsboro Borough	—	—	—	—	X
*West Deptford Township	—	—	—	—	X
Westville Borough	—	—	—	—	X
<b>MIDDLESEX COUNTY</b>					
*Old Bridge Township	—	—	X	—	—
*Perth Amboy City	—	—	X	—	X
*Sayreville Borough	—	—	X	—	X
*South Amboy City	—	—	X	—	X

TABLE I.B-1 (Continued)

County/Political Subdivision	SHORE TYPES				
	Atlantic Ocean	Inlet	Open Bay (Raritan or Delaware Bay)	Backbay, Inland Waterways, Tidal Tributaries	Major Tidal River (Delaware River)
<b>MONMOUTH COUNTY</b>					
*Aberdeen Township	—	—	X	—	—
*Allenhurst Borough	X	—	—	—	—
*Asbury Park City	X	—	—	—	—
*Atlantic Highlands Borough	—	—	X	—	—
*Avon-by-the-Sea Borough	X	X	—	X	—
*Belmar Borough	X	X	—	X	—
*Bradley Beach Borough	X	—	—	—	—
*Brielle Borough	—	—	—	X	—
*Deal Borough	X	—	—	—	—
*Fair Haven Borough	—	—	—	X	—
*Hazlet	—	—	—	X	—
*Highlands Borough	—	—	X	X	—
*Keansburg Borough	—	—	X	—	—
*Keyport Borough	—	—	X	X	—
*Little Silver Borough	—	—	—	X	—
*Loch Arbour	X	—	—	—	—
*Long Branch City	X	—	—	X	—
*Manasquan Borough	X	X	—	X	—
*Middletown Township	—	—	X	X	—
*Monmouth Beach Borough	X	—	—	X	—
*Neptune City Borough	—	—	—	X	—
*Neptune Township (Ocean Grove)	X	—	—	X	—
*Oceanport Borough	—	—	—	X	—
*Red Bank Borough	—	—	—	X	—
*Rumson Borough	—	—	—	X	—
*Sea Bright Borough	X	—	—	X	—
*Sea Girt Borough	X	—	—	—	—
*Spring Lake Borough	X	X	—	—	—
*Shrewsbury Borough	—	—	—	X	—
*Union Beach Borough	—	—	X	X	—
*Wall Township	—	—	—	X	—
<b>OCEAN COUNTY</b>					
*Barnegat Light Borough	X	—	—	X	—
Bayhead Borough	X	—	—	X	—
*Beach Haven Borough	X	—	—	X	—
*Beachwood Borough	—	—	—	X	—
*Berkeley Township	X	—	—	X	—
*Brick Township	X	—	—	X	—
*Dover Township	X	—	—	X	—
*Eagleswood Township	—	—	—	X	—
Egg Harbor City	—	—	—	X	—
Galloway Township	—	—	—	X	—
Great Egg Harbor Township	—	—	—	X	—
*Harvey Cedars Borough	X	—	—	X	—
*Island Heights Borough	—	—	—	X	—
*Lacey Township	—	—	—	X	—
*Lavallette Borough	X	—	—	X	—
*Little Egg Harbor Township	—	—	—	X	—
*Long Beach Township	X	—	—	X	—
*Mantoloking Borough	X	—	—	X	—
*Ocean Gate Borough	—	—	—	X	—
*Ocean Township	—	—	—	X	—
*Pine Beach Borough	—	—	—	X	—
*Point Pleasant Beach Borough	X	X	—	X	—
Point Pleasant Borough	—	—	—	X	—
*Sea Side Heights Borough	X	—	—	X	—
*Sea Side Park Borough	X	—	—	X	—
*Ship Bottom Borough	X	—	—	X	—
*South Toms River Borough	—	—	—	X	—
*Stafford Township	—	—	—	X	—
*Surf City Borough	X	—	—	X	—
*Tuckerton Borough	—	—	—	X	—
*Union Township	—	—	—	X	—
<b>SALEM COUNTY</b>					
*Carneys Point Township	—	—	—	—	X
*Elsinboro Township	—	—	—	—	X
Lower Alloways Creek Township	—	—	—	—	X
Oldmans Township	—	—	—	—	X
*Penns Grove Borough	—	—	—	—	X
*Pennsville Township	—	—	—	—	X

\*Municipalities which have requested or received assistance in shore protection matters from the NJDEP — Bureau of Coastal Engineering.

TABLE I.B-2

## OTHER SHORE AREAS AFFECTED BY THE MASTER PLAN

County/Open Space, Parks, Preserves and Dedicated Lands	SHORE TYPES				
	Atlantic Ocean	Inlet	Open Bay (Raritan or Delaware Bay)	Backbay, Inland Waterways, Tidal Tributaries	Major Tidal River (Delaware River)
<b>ATLANTIC COUNTY</b>					
Absecon Wetlands State Wildlife Mgt. Area	--	--	--	X	--
Brigantine National Wildlife Refuge	X	X	--	X	--
Corbin City (Tuckahoe State Wildlife Mgt. Area)	--	--	--	X	--
North Brigantine State Natural Area	X	X	--	X	--
Whirlpool Island County Recreation Area	--	--	--	X	--
<b>CAPE MAY COUNTY</b>					
*Cape May Point State Park	X	--	--	--	--
Cape May Wetlands State Wildlife Mgt. Area	--	--	--	X	--
Corsons Inlet State Park	X	X	--	--	--
Dennis Creek State Wildlife Mgt. Area	--	--	X	--	--
Higbee Beach State Wildlife Mgt. Area	--	--	X	--	--
Fishing Creek County Conservation Recreation Area	--	--	X	--	--
Strathmere State Natural Area	X	X	--	--	--
U.S. Coast Guard Receiving Center (Sewall's Point)	X	X	--	X	--
U.S. Coast Guard Reservation Wildwood Electronic Engineering Center	X	X	--	X	--
<b>CUMBERLAND COUNTY</b>					
Corsons Tract State Wildlife Mgt. Area	--	--	X	--	--
Dix State Wildlife Mgt. Area	--	--	X	--	--
Egg Island - Berrytown (Turkey Point) State Wildlife Mgt. Area	--	--	X	--	--
Fortescue State Wildlife Mgt. Area	--	--	X	--	--
Heislerville State Wildlife Mgt. Area	--	--	X	--	--
<b>MONMOUTH COUNTY</b>					
Fort Monmouth (U.S. Army)	--	--	--	X	--
Hartshorne County Park	--	--	--	X	--
*Manasquan River State Wildlife Mgt. Area	--	--	--	X	--
Naval Weapons Station Earle (Leonardo)	--	--	--	X	--
New Jersey National Guard Camp (Sea Girt)	X	--	--	--	--
*Sandy Hook - Gateway National Park	X	--	X	--	--
*Sandy Hook Coast Guard Station	X	--	--	--	--
Shark River County Park	--	--	--	X	--
<b>OCEAN COUNTY</b>					
*Barnegat Light State Park	X	X	--	X	--
Barnegat National Wildlife Refuge	--	X	--	X	--
Brigantine National Wildlife Refuge	--	X	--	X	--
Cattus Island County Park	--	--	--	X	--
Great Bay Boulevard State Natural Area	--	X	--	X	--
*Island Beach State Park, Research Area and Wildlife Sanctuary	X	X	--	X	--
*Manahawkin State Fish & Wildlife Mgt. Area	--	--	--	X	--
Swan Point State Natural Area	--	--	--	X	--
<b>SALEM COUNTY</b>					
Artificial Island Disposal Area (USACOE)	--	--	--	--	X
*Fort Mott State Park	--	--	--	--	X
Killcohook National Wildlife Refuge	--	--	--	--	X
Killcohook Federal Spoil Disposal Area (USACOE)	--	--	--	--	X
Mad Horse Creek State Wildlife Mgt. Area	--	--	--	--	X
Pedricktown Disposal Area (USACOE)	--	--	--	--	X
Supawana Meadows National Wildlife Refuge	--	--	--	--	X

\*Areas which have received assistance in shore protection matters from the NJDEP - Bureau of Coastal Engineering.

TABLE I.B-3  
SHORELINE REACH CLASSIFICATION

SHORELINE ZONE**	REACH NUMBER	REACH DESCRIPTION	COUNTY	POLITICAL SUBDIVISION (MUNICIPALITIES/PARKS, ETC.)	VILLAGE*, PARK UNIT, ETC.
Raritan Bay	1	Raritan Bay	Middlesex	Perth Amboy City South Amboy City  Sayreville Borough Old Bridge Township	Melrose South Amboy Junction Morgan Lawrence Harbor
			Monmouth	Aberdeen Township Keyport Borough Union Beach Borough Keansburg Borough Middletown Township  Naval Weapons Station Earle (Leonardo) Atlantic Highlands Borough Highlands Borough	Cliffwood Beach  Port Monmouth Belford Leonardo
Northern Barrier Spit	2	Sandy Hook to Long Branch		Gateway National Recreation Area and U.S. Coast Guard Station Sea Bright Borough  Monmouth Beach Borough	Sandy Hook Unit  Highland Beach Navesink Beach Low Moor Galilee
Headland	3	Long Branch to Shark River Inlet		Long Branch City  Deal Borough Allenhurst Borough Loch Arbour Asbury Park City Neptune Township Bradley Beach Borough Avon by the Sea	North Long Branch Long Branch City West End Elberon  Ocean Grove
	4	Shark River Inlet to Manasquan Inlet		Belmar Borough Spring Lake Borough Sea Girt Borough State Arsenal and Camp Ground Manasquan Borough	
	5	Manasquan Inlet to Mantoloking	Ocean	Point Pleasant Beach Borough Bay Head Borough	
Northern Barrier Island Complex	6	Mantoloking to Barnegat Inlet	Ocean	Mantoloking Borough Brick Township Dover Township  Lavallette Borough Sea Side Heights Borough Sea Side Park Borough Berkeley Township Island Beach State Park	South Mantoloking Beach Normandy Beach Chadwick Ortley Beach  South Sea Side Park
	7	Barnegat Inlet to Little Egg Inlet (Long Beach Island)		Barnegat Lighthouse State Park Barnegat Light Borough Harvey Cedars Borough Surf City Ship Bottom Borough Long Beach Township  Beach Haven Borough Brigantine National Wildlife Refuge	Holly Lagoons Lighthouse Park South Loveladies North Beach Brant Beach Beach Haven Crest Brighton Beach Peahala Beach Haven Park Haven Beach The Dunes Beach Haven Terrace Beach Haven Gardens Spray Beach North Beach Haven Beach Haven Manor Holgate South Branch Haven Beach Haven Heights  Holgate Unit

\*Village as presented here are the non-governmental (non-taxable) entities occurring within a particular shore municipality

\*\*Shoreline Zones are discussed in Chapter II, Section B.

TABLE I.B-3 (Sheet 2 of 3)

SHORELINE ZONE	REACH NUMBER	REACH DESCRIPTION	COUNTY	POLITICAL SUBDIVISION (MUNICIPALITIES/PARKS, ETC.)	VILLAGE*, PARK UNIT, ETC.
Southern Barrier Island Complex	8	Little Egg Inlet to Absecon Inlet (Pullen Island and Brigantine Island)	Atlantic	Brigantine National Wildlife Refuge North Brigantine State Natural Area Brigantine City	Little Beach Unit (Pullen Island)
	9	Absecon Inlet to Great Egg Harbor Inlet (Absecon Island)		Atlantic City Ventnor City Margate City Longport Borough	
	10	Great Egg Harbor Inlet to Corson Inlet (Pecks Beach)	Cape May	Ocean City Corson Inlet (Ocean Crest) State Park	
	11	Corsons Inlet to Townsends Inlet (Ludlam Island)		Strathmere State Natural Area Upper Township Sea Isle City	Strathmere Whale Beach
	12	Townsends Inlet to Hereford Inlet (Seven Mile Beach)		Avalon Borough Stone Harbor Borough	
	13	Hereford Inlet to Cape May Inlet (Five Mile Beach)		North Wildwood City Wildwood City Wildwood Crest Borough Lower Township (East) U.S. Coast Guard, Wildwood Electrical Engineering Center	Wildwood Gables
Southern Headlands	14	Cape May Inlet to Cape May Point		U.S. Coast Guard Receiving Area Cape May City Cape May Point State Park Lower Township (South) Cape May Point Borough	
Delaware Bay	15	Delaware Bay Cape May Point to Stow Creek	Cape May	Lower Township (West)  Higbee Beach State Wildlife Mgt. Area Middle Township  Dennis Creek State Wildlife Mgt. Area Dennis Township	Sunset Beach North Cape May Town Bank Wildwood Highlands Beach North Highlands Beach Villas Miami Beach  Sunray Beach Highs Beach Pierces Point Kimbles Beach Reeds Beach
			Cumberland	Maurice River Township Corson Tract State Fish and Wildlife Mgt. Area Heislerville State Wildlife Mgt. Area Commercial Township Downe Township  Egg Island-Berrytown (Turkey Point) State Wildlife Mgt. Area Fortescue State Wildlife Mgt. Area Lawrence Township Fairfield Township Dix State Wildlife Mgt. Area Greenwich Township	Moores Beach Thompsons Beach  Fortescue Beach Gandy's Beach  Sea Breeze Bayside

TABLE I.B-3 (Sheet 3 of 3)

SHORELINE ZONE	REACH NUMBER	REACH DESCRIPTION	COUNTY	POLITICAL SUBDIVISION (MUNICIPALITIES/PARKS, ETC.)	VILLAGE*, PARK UNIT, ETC.
Delaware River	16	Delaware River Stow Creek to Crosswicks Creek	Salem	Lower Alloways Creek Township Mad Horse Creek State Wildlife Mgt. Area Artificial Island Federal Disposal Area Elsinboro Township  Supawna Meadows National Wildlife Refuge Fort Mott State Park Killecohook National Wildlife Refuge Killecohook Federal Dredge Disposal Area Pennsville Township  Carneys Point Township Penns Grove Borough Oldmans Township Pedricktown Federal Disposal Area U.S. Military Reservation	Fort Elfsdorf Oakwood Beach  Penns Beach Church Landing Deepwater  Dolbews Landing
			Gloucester	Logan Township Greenwich Township Paulsboro Borough West Deptford Township National Park Borough Westville Borough	Billingsport
			Camden	Gloucester City Camden City Pennsauken Township	
			Burlington	Palmyra Borough Riverton Borough Cinnaminson Township Delran Township Delanco Township Beverly, City of Edgewater Park Township Burlington Township Burlington City Florence Township Mansfield Township Fieldsboro Township Bordentown Township Bordentown City	

## C. THE NEW JERSEY SHORE: CONDITIONS, FEATURES, AND PROCESSES

### 1. Introduction

The New Jersey coastline represents a dynamic interface between the land and the sea. The shoreline has been gradually moving and changing its configuration from the time sea level began to rise on the continental shelf at the end of the glacial age some 12,000 to 15,000 years ago. Although the native Americans summered at the shore as the present inhabitants do, coastal erosion was not a problem until development of major shore resorts began in the mid-1800's and early 1900's. Towns such as Long Branch, Asbury Park, Ocean City, Atlantic City and Cape May, easily accessible by railroads from the population centers of New York and Philadelphia, rapidly developed with hotels, restaurants, boarding houses, bath houses and boardwalks. The major goal was to build as near the ocean as possible and very little consideration was given to natural coastal processes in the planning or layout of the resorts. Thus, very early the stage was set for erosion to threaten buildings and, therefore, to be a major problem along the New Jersey coast.

As early as the turn of the century, following the example of the railroads which first built protective devices to keep their rail lines open, civic authorities advocated construction of protective measures such as jetties, groins, seawalls, and breakwaters to protect their ever-appreciating shore recreation property and industry. All of these measures represented major capital expenditures on all governmental levels. Each municipality had different erosion problems and limited resources so that attempts to cope with erosion focused on short-term, stop-gap measures tailored to each locality instead of considering the region as a whole and the underlying natural causes of shoreline erosion and change.

### 2. Erosional Conditions

Only relatively recently have coastal residents and governmental agencies begun to focus on shoreline erosion as more than a series of short-term crises at a series of independent locations. The U.S. Army Corps of Engineers in 1971, as part of the National Shoreline Inventory, classified the U.S. coast as critical, non-critical or non-eroding. In its effort to determine where significant erosion occurs, rates of erosion were considered in conjunction with economic, industrial, recreational, agricultural, navigational, demographic, ecological, and other relevant factors to identify those areas where action to halt such erosion may be justified. Areas so identified were considered critical. Other areas undergoing significant erosion were classified as non-critical. For the Atlantic coastal shoreline of New Jersey, 81 percent (101 miles) was considered critical, 9.7 percent (12 miles) was considered non-critical, and 8.8 percent (11 miles) was considered non-eroding.

In 1977, the Center for Coastal and Environmental Studies (CCES) at Rutgers University completed a study commissioned by the NJDEP, entitled Coastal Geomorphology of New Jersey. That study analyzed the problems of shoreline erosion, classified the shoreline and identified thirteen specific examples of high risk erosion areas:

- o Cumberland County — Delaware Bay Shore (developed portions along bay-shore)
- o Middle Township (developed portions of bayshore), Cape May County
- o Cape May City
- o Northern Wildwood (where Hereford Inlet fronts beach)

- o Strathmere (Putnam Avenue to end of developed island)
- o Ocean City (3rd St. to 18th St.)
- o Ocean City (E. Atlantic Blvd. to Newcastle Rd.)
- o Atlantic City (where Absecon Inlet fronts beach, Oriental Ave. to Parkside)
- o Barnegat Light (8th to 4th St.)
- o Loch Arbour to Elberon
- o Long Branch
- o Sea Bright and Monmouth Beach
- o Raritan Bay (developed portions along bayshore)
- o Sea Isle City (southern half)

In preparation of the Shore Protection Master Plan, an inventory of the shoreline geomorphic character and erosion condition was performed to update earlier assessments of coastal erosion and damage, or the threat of damage, to the shore areas of the State. This task was accomplished through literature review, aerial and ground reconnaissance, aerial photo analysis, and workshop discussion with engineers and planners representing the affected municipalities. Literature search activities included a review of references on file with the Philadelphia District Corps of Engineers, the New Jersey Department of Environmental Protection, and the U.S. Army Coastal Engineering Research Center.

The method of analysis consisted of a thorough evaluation of the condition of the New Jersey shoreline using the above sources of information as primary data and the classification of the shoreline according to severity of erosion. The classification of erosion conditions below represents a refinement of erosion severity for developed portions of the New Jersey shoreline and differs from the U.S. Army Corps of Engineers' National Shoreline Inventory Study in three ways; 1) it considers only physical parameters as a measure of the severity of the erosion process, 2) it is uniformly applied to developed areas, and 3) the range of erosion severity is further classified (I, II, and III).

As discussed in Section I.B.2 above, reaches were defined on the basis of coastal forms and processes. Within each reach definitive erosion patterns exist that can be classified according to severity. By virtue of the predominant erosion or accretion trend, a particular area of developed shoreline was classified into one of the following categories:

Category I	-	Critical erosion
Category II	-	Significant erosion
Category III	-	Moderate erosion
Category IV	-	Non-eroding

The classification for a given area of shoreline is directly related to the degree and magnitude of existing and potential erosional damage. The degree and magnitude of this damage was estimated with respect to the criteria listed in Table I.C-1.

TABLE I.C-1  
CRITERIA FOR EROSION CLASSIFICATION

- o Beach width
- o Presence of dunes
- o Littoral transport budget
- o Shoreline mobility
- o Presence of shore protection structures
- o Condition of shore protection structures
- o Functional performance of shore protection structure
- o Proximity of development and infrastructure to mean high water line
- o Wave climate

The severity of shoreline erosion was evaluated by combining the criteria in Table I.C-1 with a temporal consideration. Category I areas are characterized as having the least suitable natural and man-made protection from the operating erosive forces. These are areas presently receiving significant erosive attack and damage to protective features, or areas which are threatened with imminent attack by small or moderate storms. Category II areas are areas where a low to moderate level of protection exists, but where erosive forces are expected to reduce this level in time thus posing a longer term threat of significant damage to developed areas than exists for Category I areas. Category III represents an area which has a moderate to high degree of protection (natural and/or man-made) for the level of erosive processes that are operative. The temporal occurrence of significant damage from erosion is not expected for a period longer than that for Category II. Category IV areas are those which are presently non-eroding or are considered stable. This classification is based on long-term trends and does not account for extreme storm events such as a hurricane or intense extratropical storm such as a northeaster.

As pointed out by Nordstrom and others (1977), and as indicated by a review of the Proceedings of the National Conference on Coastal Erosion (FIA, July, 1977), reliable quantified methodologies based on erosion rates do not presently exist for precisely delineating future erosional trends. This is especially true for areas such as the New Jersey shoreline where the wide distribution of shore protection structures and other development further complicate the problem. Therefore, the application of the above criteria required professional judgement in the evaluation of the data. Assignment of ocean shore areas into the various erosion categories represents qualitative determinations as to the relative severity of the erosion.

The results of the classification of the developed ocean shores is presented in Table I.C-2 and the distribution of the erosion classification for the reaches is presented in Figures I.C-1 to I.C-4. For the ocean shores as a whole, 32.9 percent of the total length is considered as Category I (critical erosion), 18.0 percent as Category II (significant erosion), 38.5 percent as Category III (moderate erosion) and 10.6 percent as non-eroding, Category IV. The percentage of each reach which is classified as Categories I and II, and the percentage that each reach represents of the total category for the New Jersey shoreline for both Category I and for I plus II, is presented in Table I.C-3. Reaches which have a significant portion of their shoreline classified as Category I or I plus II, and also represent a significant portion of the total New Jersey I plus II, include Reach 2 (Sandy Hook to Long Branch), Reach 3 (Long Branch to Shark River Inlet), Reach 9 (Absecon Island), Reach 10 (Pecks Beach), Reach 11 (Ludlam Island), and Reach 14 (Cape May Canal to Cape May Point). These areas thus represent the most seriously threatened reaches in New Jersey.

TABLE I.C-2

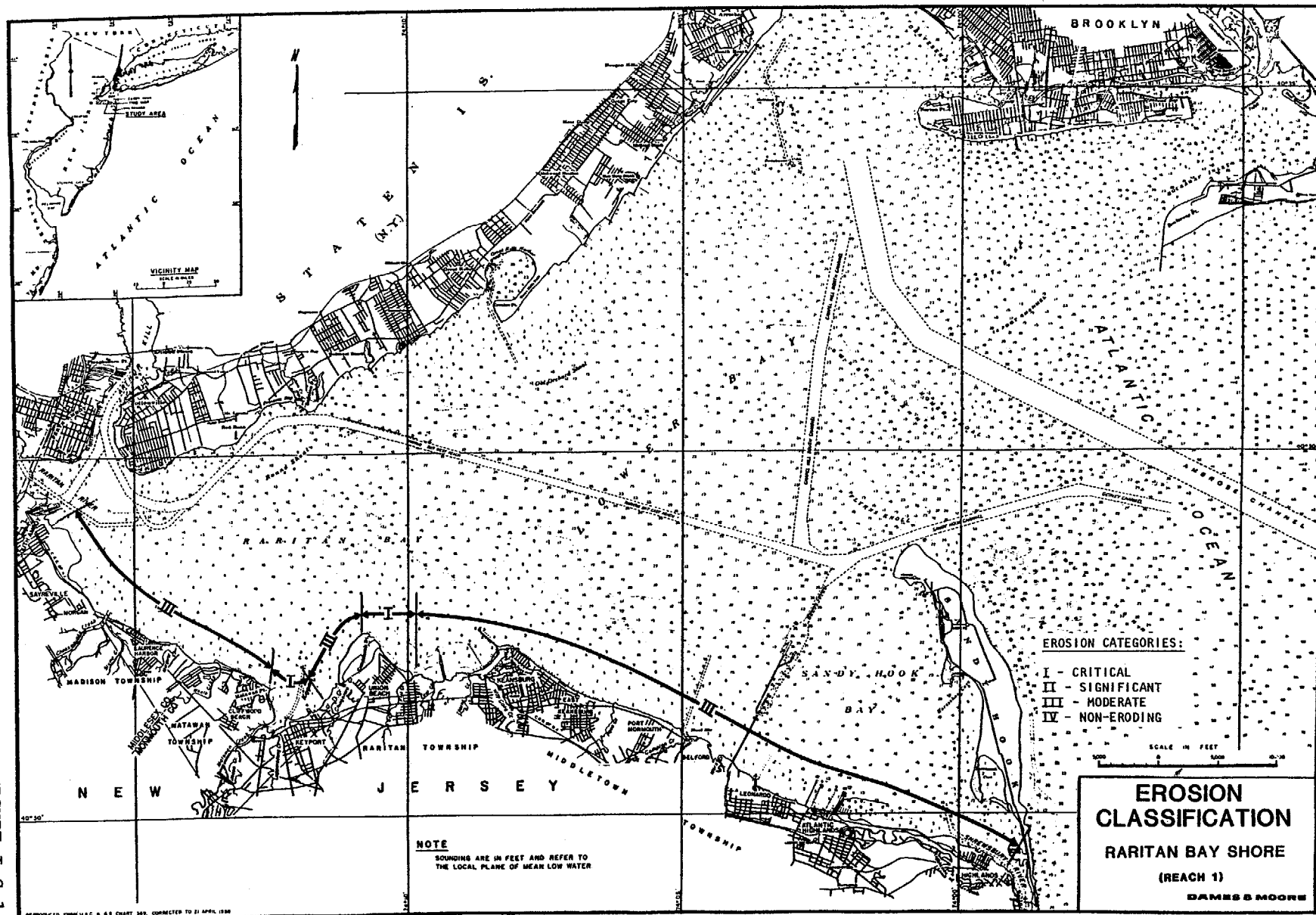
## OCEANFRONT EROSION CLASSIFICATION RESULTS BY REACH\*

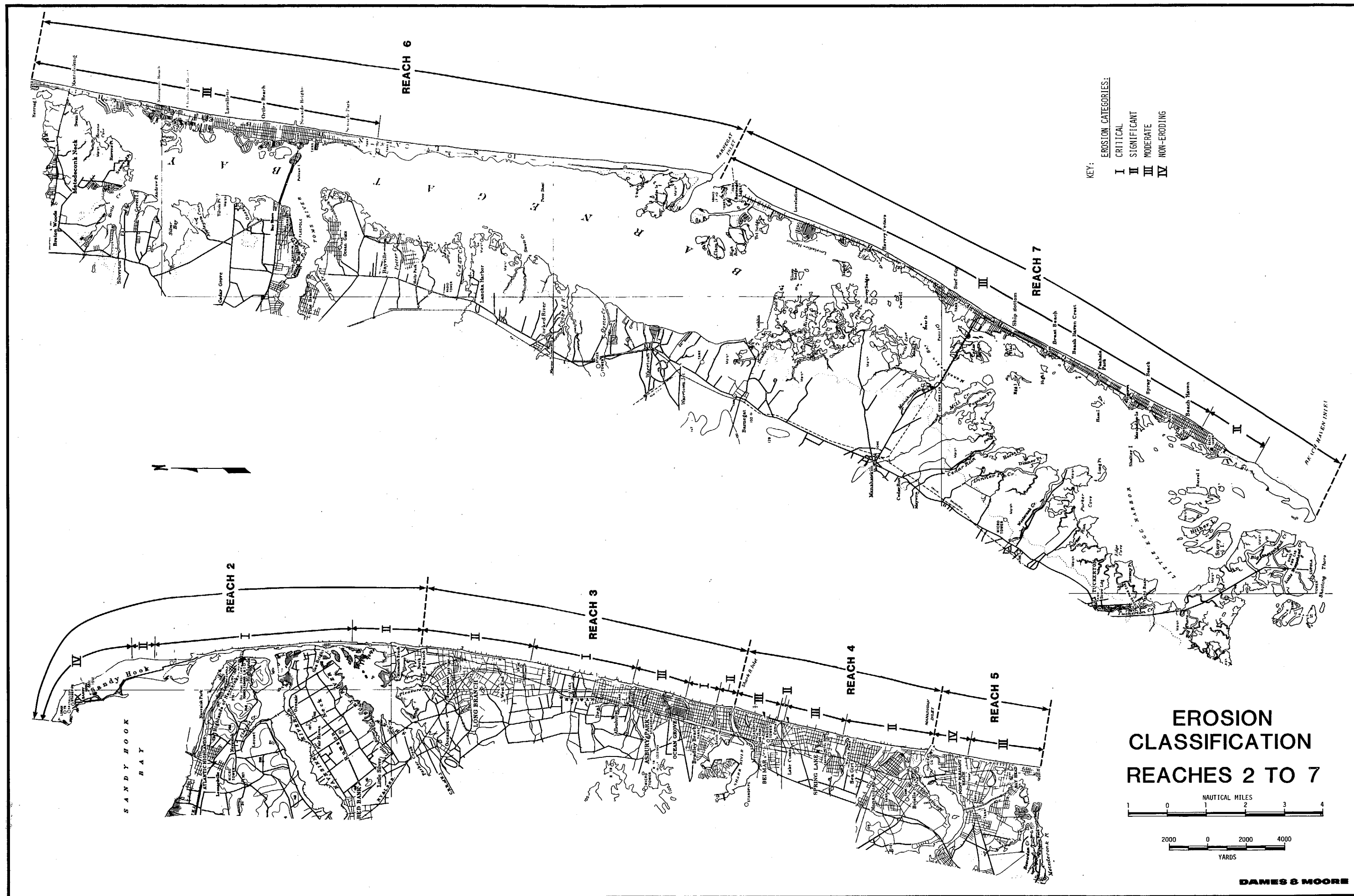
Reach Number	Reach Name	Length in Category (ft)			
		I Critical Erosion	II Significant Erosion	III Moderate Erosion	IV Non- Eroding
2	Sandy Hook to Long Branch	31,900	10,700	—	17,700
3	Long Branch to Shark River Inlet	22,200	19,500	8,700	—
4	Shark River Inlet to Manasquan Inlet	—	14,300	16,200	—
5	Manasquan Inlet to Mantoloking	—	—	11,250	5,400
6	Mantoloking to Barnegat Inlet	—	—	86,000	—
7	Long Beach Island	—	10,200	86,000	—
8	Brigantine Island	7,800	3,750	5,100	4,650
9	Absecon Island	8,700	17,600	16,500	—
10	Pecks Beach	41,400	2,400	—	—
11	Ludlam Island	35,000	1,200	—	—
12	Seven Mile Beach	19,100	4,500	—	—
13	Five Mile Beach	—	10,800	9,300	12,300
14	Cape May Inlet to Cape May Point	18,700	6,100	7,800	—
Total		184,800	101,050	216,200	59,850
% Total		32.9%	18.0%	38.5%	10.6%

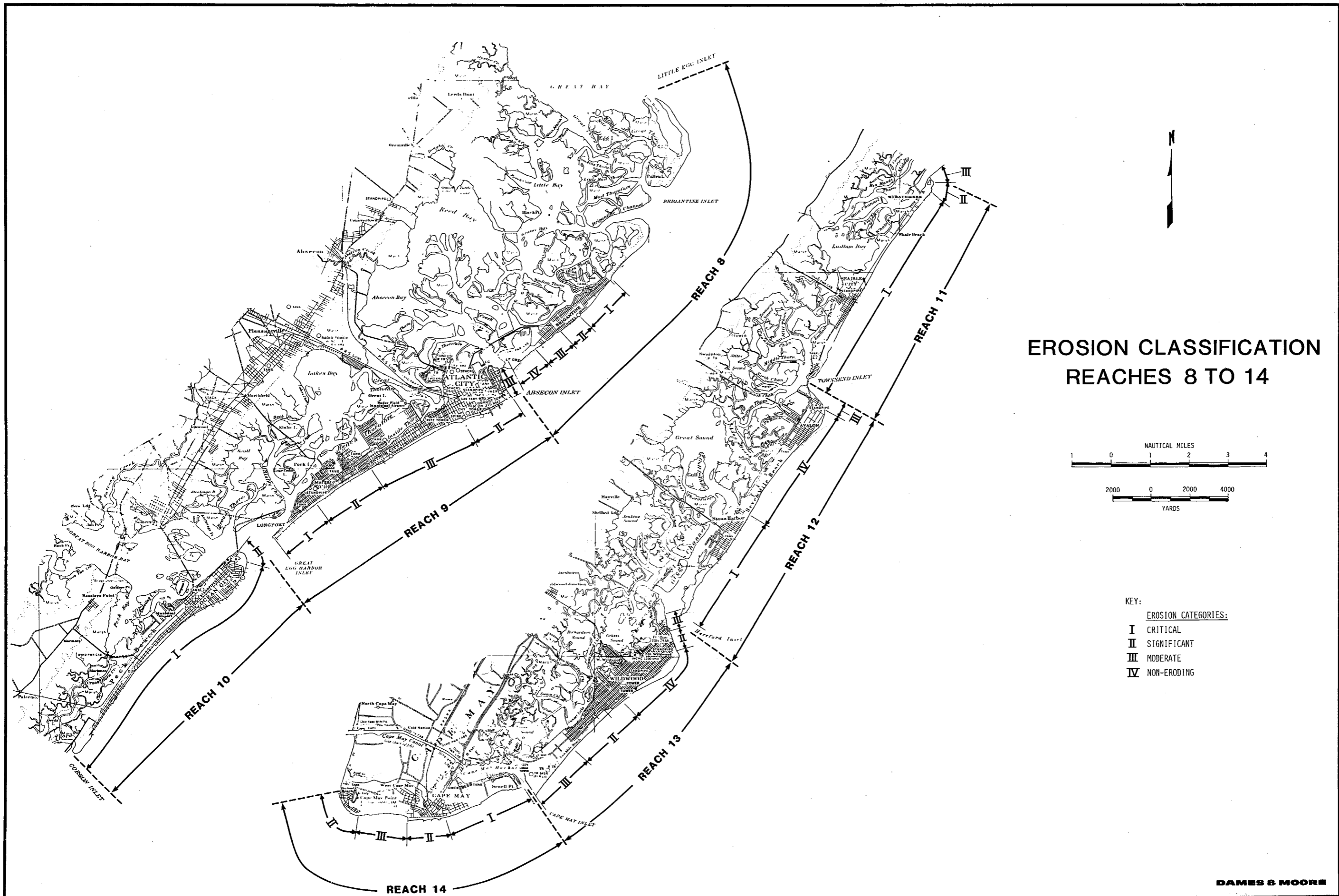
\*Excluding Island Beach State Park in Reach 6, Brigantine National Wildlife Refuge and North Brigantine State Natural Area in Reach 8, Raritan Bay (Reach 1), and Delaware Bay and River (Reaches 15 and 16).

I-15

FIGURE I.C-1







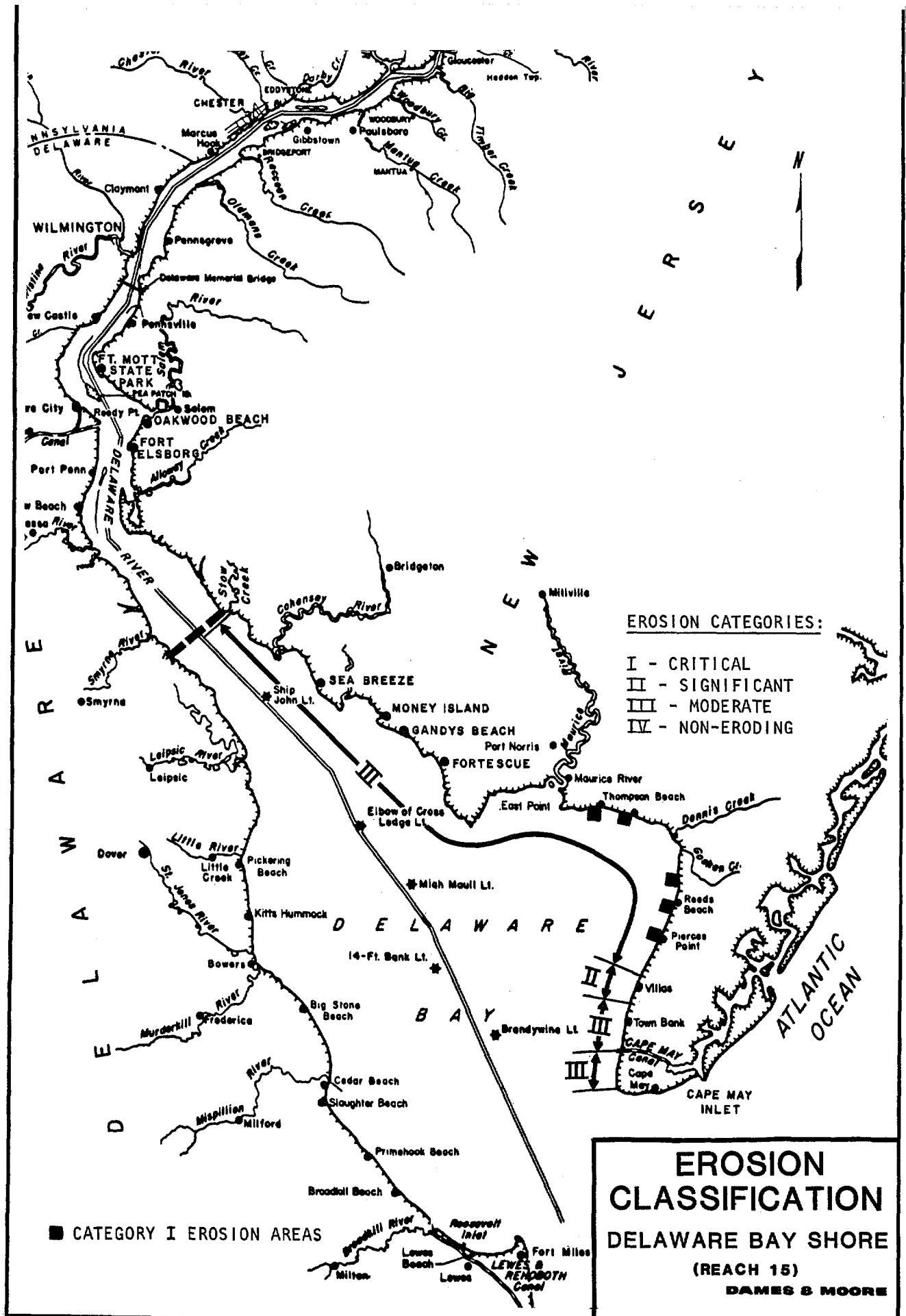


TABLE I.C-3

## SUMMARY EROSION CLASSIFICATION OF OCEAN SHORELINE BY REACH

Reach Number	Reach Name	Percent I & II Of Total Reach	Percent of Total I For N.J. Shoreline	Percent of Total I & II For N.J. Shoreline
2	Sandy Hook to Long Beach	70.6	17.3	14.9
3	Long Branch to Shark River Inlet	82.7	12.0	14.6
4	Shark River Inlet to Manasquan Inlet	46.9	0.0	5.0
5	Manasquan Inlet to Manatoloking	0.0	0.0	0.0
6	Mantoloking to Barnegat Inlet	0.0	0.0	0.0
7	Long Beach Island	10.6	0.0	3.6
8	Brigantine Island	54.3	4.2	4.0
9	Absecon Island	61.4	4.7	9.2
10	Pecks Beach	100.0	22.5	15.3
11	Ludlam Island	100.0	18.9	12.6
12	Seven Mile Beach	54.4	10.3	8.3
13	Five Mile Beach	33.3	0.0	3.8
14	Cape May Inlet to Cape May Point	76.1	10.1	8.7
			100.0	100.0

In addition to the developed ocean shore areas, local erosion problem areas (Category I) are also found on the bay Reaches 1 and 15. Inlet shores at the north end of Reaches 9, 12 and 13 also have localized erosion problem areas of varying severity. The south shores of Absecon Inlet (Reach 9), Townsend Inlet (Reach 12) and Hereford Inlet (Reach 13) have historically experienced erosion problems resulting from the dynamic migration of the inlet systems. Attempts to stabilize these inlet shores are evident in the presence of bulkheads, revetments, groins, and jetties installed at various times by the State and local municipalities. Despite these measures, the problems persist in some areas, especially where structures are inadequate or are in need of repair. Similar erosion problems on the south shores of Great Egg Harbor Inlet (Reach 10) and Corsons Inlet (Reach 11) have been restabilized by the State utilizing beach fill and groins.

Based on the above analysis, portions of shoreline within ten reaches (8 ocean and 2 bay reaches) have been identified as Category I — critical erosion areas. In general, for all Category I areas, the probability of significant damage to vital shore protection structures, private or public buildings, or the infrastructure is high.

Engineering measures must consider not only the critical portions of a reach, but the entire reach, including lesser eroding areas, to ensure that any alternative does not adversely affect any other portion of the reach. This is the rationale of planning by reach and is the fundamental principle of the Master Plan as discussed in Section II.B.1 of this Volume. In Volume 2, Section II.B., each reach having critical erosion problems is briefly discussed in terms of the magnitude of erosion and existing structures.

### 3. Coastal Features and Processes

The natural dynamics of the coastal system must be evaluated in any study of shoreline erosion to determine potential hazards and mitigation measures. In New Jersey, about 80 percent of the open ocean coast consists of barrier island and spits; the remaining 20 percent is headlands. Dolan and others (1980) have recently summarized the natural processes of the coastal barrier systems as they relate to the hazards associated with this environment.

This section describes the New Jersey shore forms and reviews the shoreline processes and geomorphic response of the shore segments in time and space, with particular attention to the barrier system. This information will facilitate an understanding of beach erosion as related to development in the coastal areas and as input to the evaluation of alternative mitigation measures. Additional summary information on coastal, estuarine, and barrier island processes is available in annotated bibliographies by Sinha and McCosh (1974) and Gulf South Research Institute (1978).

#### a. Description of Shore Forms

The geomorphology of the New Jersey coastal forms has been reviewed by Nordstrom (1977) and Yasso and Hartman (1975), who recognize the following major geomorphic components of the shore (Figure I.C-5):

- o Raritan Bay, 22 miles long
- o Northern Barrier Spit (Sandy Hook), 10 miles long
- o Northern Headlands, 19 miles long
- o Northern Barrier Island Complex, 42 miles long
- o Southern Barrier Island Complex, 48 miles long

- o Southern Headland (Cape May), 5 miles long
- o Delaware Bay, 91 miles long
- o Delaware River, 60 miles long (south of Trenton).

Except for the presence of the small Southern Headlands component at Cape May, the New Jersey coastal geomorphic pattern is strikingly similar to the other major coastal compartments in the mid-Atlantic region (Cape Cod, Long Island, Delmarva Peninsula, and North Carolina). Each of these compartments is characterized by: (1) a northern or cusped spit, (2) an eroding headland, (3) a southern-barrier island, and (4) a southernmost barrier island chain (Fisher, 1967, in Swift, 1969).

In New Jersey, the Northern Headlands area (most of Monmouth County) is characterized by narrow beaches at the base of subdued bluffs which have been eroded from the unconsolidated Coastal Plain formations. The beach sands are coarse-to-medium in size, with a characteristic mineral composition whose source can be traced to the Coastal Plain formations (McMaster, 1954). Coarser grain sands and this distinctive mineralogy also characterize the Sandy Hook spit to the north and the Northern Barrier Island Complex to the south. The coarser sand sizes in this northern sector result in steeper beaches and offshore profiles. The Northern Headlands extend from Monmouth Beach on the north through Long Branch, Asbury Park, and Point Pleasant to Bay Head on the south. The low headlands for this area have elevations of 15 to 25 feet and terminate in a low bluff line which borders the narrow beach. Headland elevations diminish and the beach widens progressively to the southern terminus of the headlands.

The Northern Barrier Island Complex consists of two long barrier elements: (1) the south-prograding Barnegat barrier which extends 21 miles from Bay Head to Barnegat Inlet and (2) Long Beach Island, 20 miles to the south. The tidal lagoons or backbays behind these barriers are quite wide, ranging from 3 to 4 miles in most places.

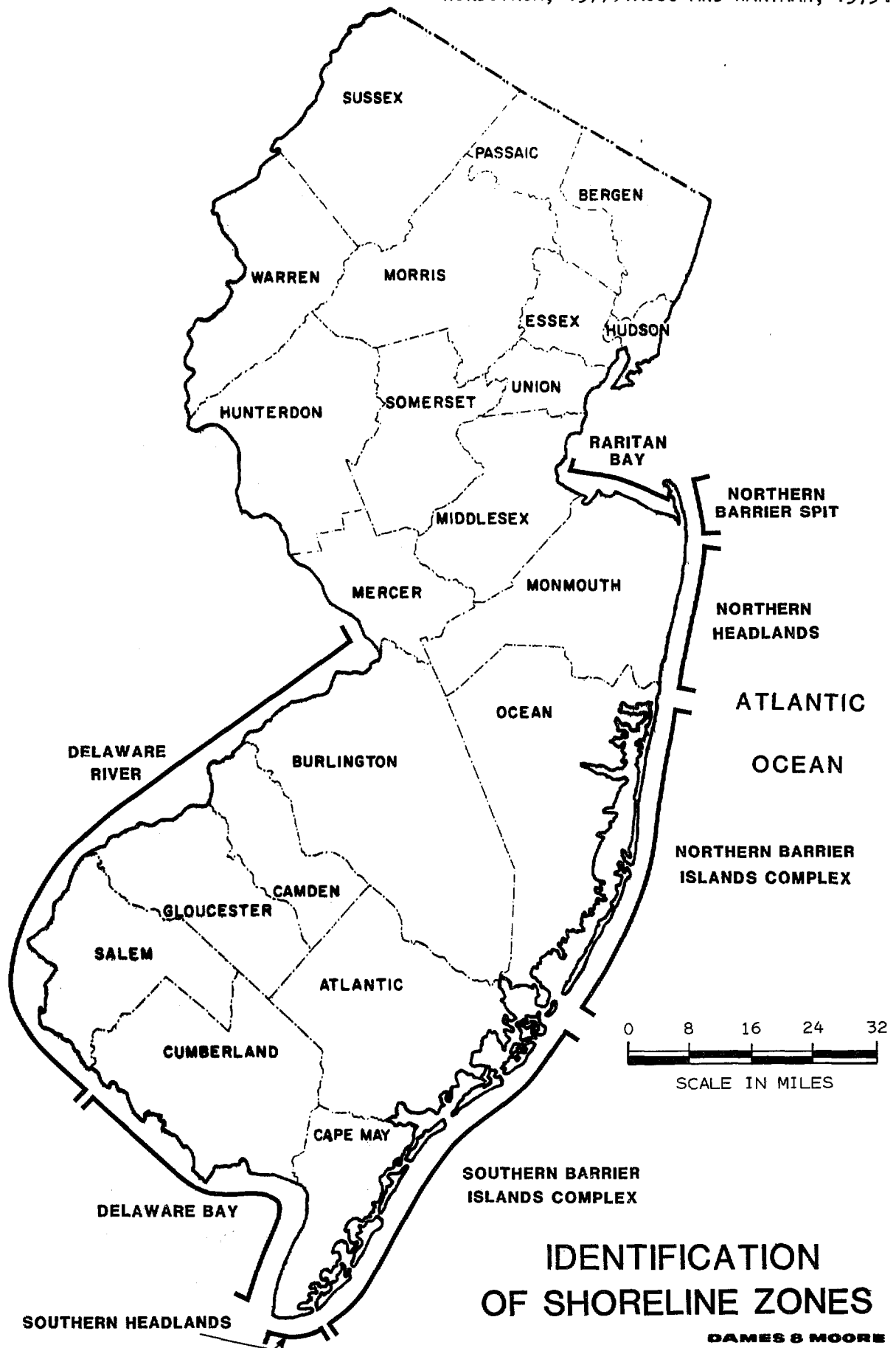
The Southern Barrier Island Complex consists of a chain of smaller islands separated by seven inlets. This complex is separated from the Northern Complex by the large double inlet system of Beach Haven-Little Egg Inlet. The beaches of the Southern Barrier Island Complex are characterized by fine-grain sand sizes and the resulting flatter beach slopes, as well as a heavy mineral assemblage distinctive from the northern beaches (McMaster, 1954). The Beach Haven-Little Egg Inlet system represents a sharp boundary between the compositional and textural characteristics of the northern beaches (medium-to-coarse sizes and opaque heavy minerals) and the beaches to the south (fine sizes and hornblende-garnet heavy minerals).

The islands and inlets of the Southern Barrier Island Complex, listed from north to south, are:

- |                     |                                 |
|---------------------|---------------------------------|
| o Pullen Island     | o Brigantine Inlet              |
| o Brigantine Island | o Absecon Inlet                 |
| o Absecon Island    | o Great Egg Inlet               |
| o Peck Beach        | o Corson's Inlet                |
| o Ludlum Island     | o Townsend's Inlet              |
| o Seven Mile Island | o Hereford Inlet                |
| o Five Mile Island  | o Cape May (Cold Spring) Inlet. |

Except for Pullen Island, which is only about 2 1/2 miles long, the average length of the islands in the Southern Complex is 5 to 6 miles. The northern islands are characteristically larger.

REFERENCE:  
NORDSTROM, 1977; YASSO AND HARTMAN, 1975.



The terrain along the Raritan Bay shore between Perth Amboy and the Shrewsbury River ranges from high bluffs near the west and east ends to low marshlands which are partially inundated by high tides. Present beaches are low and narrow, and a number of tidal creeks intersect the shoreline. The offshore hydrography is mostly very shallow and flat, with the 12-foot-depth contour generally located over a mile offshore, except in the eastern portion of the bay shore where depths are greater. Much of the shoreline is structurally stabilized with groins, bulkheads, and revetments, except for the artificially filled areas between Port Monmouth and Sayreville. Where structures exist, they have generally been effective in controlling shoreline erosion. However, as is the case along the Atlantic shore, most beaches seaward of these structures have been lost by erosion. Locally, artificially filled beaches, as at Keansburg, have provided a measure of protection as well as a recreational beach.

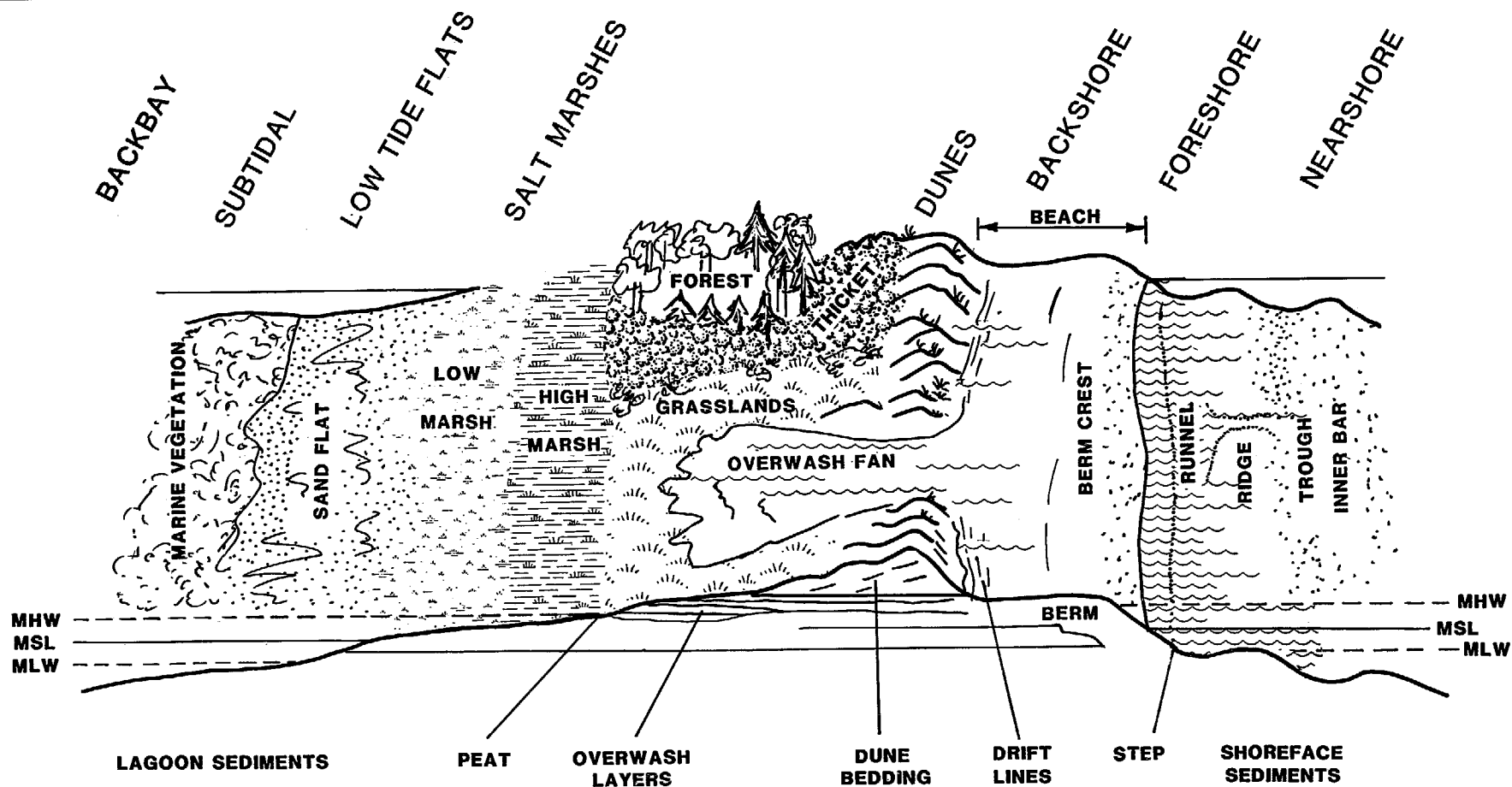
The Delaware Bay shore is naturally divided into two rather distinct geomorphic sections. From Cape May Point to Bidwell Creek (approximately 11 miles), the shore is characterized by low bluffs fronted by a low narrow strip of eroding coarse sandy beach. From Bidwell Creek to Stow Creek (approximately 80 miles), the bay shore is characterized as an irregular, low, eroding salt marsh coast with isolated small beaches backed by low dunes and firm ground. The irregular salt marsh coast continues to dominate the shoreline up the Delaware River to the mouth of Salem River. The Delaware Bay and lower Delaware River shore are drained by small tidal tributary streams and creeks, many of which have been improved under Federal navigation projects.

The main stem of the Delaware River begins at the confluence of the West Branch and East Branch near Hancock, New York, about 197 river miles above Trenton (where the river becomes tidal). From Trenton south, the river has been improved under Federal navigation projects. The river shore from Salem River to Trenton is highly developed and industrialized, with port commerce at Camden, Gloucester, and Paulsboro.

#### b. Shoreline Dynamics

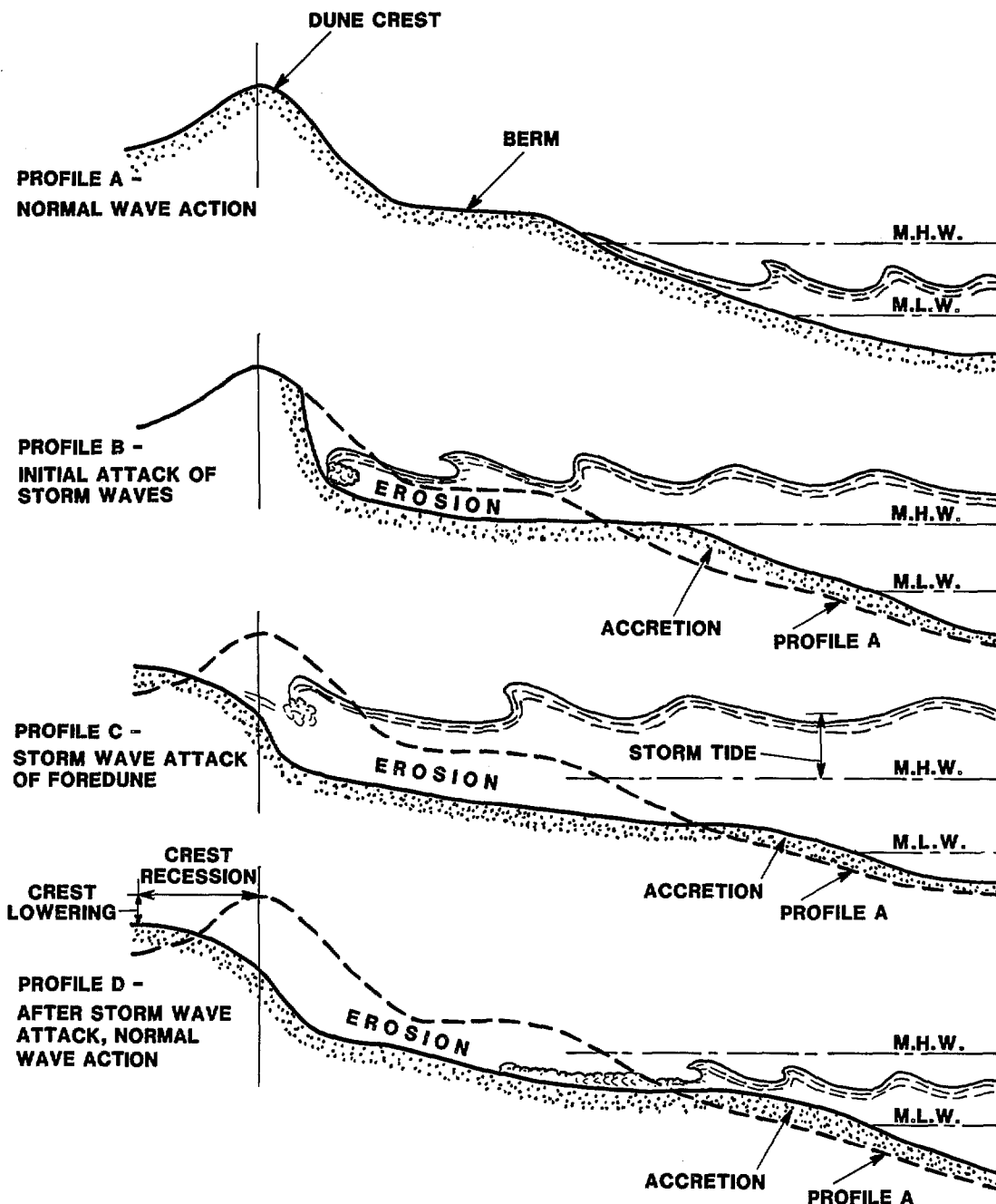
(1) Components of the Barrier System (Islands and Spits). For convenience, both the barrier islands and barrier spits will be referred to here as barrier islands. Each island is an elongated, narrow landform consisting primarily of unconsolidated sand. The islands represent a dynamic response to the surrounding wind, wave, and tidal forces that cause the constant shifting of sand along the beach and through the dune system. The basic features of a barrier island are presented in Figure I.C-6, which presents a generalized model for an undeveloped barrier island and is used to illustrate the major elements of the natural barrier's response to the dynamics of the environment.

A typical beach is divided into the foreshore and backshore zones. The foreshore is the sloping portion of the beach which absorbs wave energy. The backshore is characterized by a berm, which is the least stable portion of the system. Natural storm berms, created by storm waves, may be present in the inner portion of the backshore. The berm crest is marked by a ridge of sand at the top of the wave uprush. The flat berm area or backshore beyond this crest forms the main area of the dry beach. Wind blowing inland from the foreshore and berm transports the fine size sand to form dunes. Sand is also transported from the barrier flats and overwash areas by winds blowing from the bay side. As dunes build up, they provide both a natural protection line against storm wave attack and a reservoir of sand that "sacrifices itself" while dissipating storm wave energy (Figure I.C-7).



## MODEL OF AN UNDEVELOPED BARRIER ISLAND

REFERENCE: ADOPTED FROM GODFREY, 1976.



## SCHEMATIC DIAGRAM OF STORM WAVE ATTACK ON BEACH AND DUNE

REFERENCE: ADAPTED FROM USACOE, CERC, 1977.

DAMES & MOORE

Almost all beaches are in a constant state of flux. The rise in tidal levels which accompanies a storm event results in the concentration of wave energy in a higher zone on the normal beach profile. This results in the flattening of the overall profile due to erosion of the berm and dune areas and deposition of the eroded material offshore. The beach is subsequently rebuilt by the transport of this offshore sand by waves associated with calmer periods. The rising water levels may be capable of breaching the dune system in low areas and transporting sand to the back portion of the barrier as overwash deposits.

Longer term beach erosion and accretion occur with changes in the general wave climate associated with seasonal storms. During stormy seasons, usually in winter to spring, the larger short-period waves and more frequent storms tend to move sand off the beach, depositing it in shallow offshore sand bars. During the calm weather, the typical long-period ocean swell waves tend to move sand inshore, rebuilding the beaches.

Although the Raritan Bay, Delaware Bay, and backbay shores are also being eroded by waves and high tides associated with storms, they are generally sheltered from the constructive long-period ocean swell waves. Despite the relatively low average wave energies that characterize the bay-shore areas, normal and storm erosion deplete the shores by depositing eroded materials offshore without allowing for the replenishment of the beach by natural processes. This problem is further intensified where shore erosion control structures have been constructed, thus depleting potential new sources of beach material.

(2) Littoral Drift. The barrier islands and headlands along the coast represent a dynamic response to the forces of wind, waves, and tides. Waves impinge on the shore and move the sand along as littoral drift when they approach at an angle to the shore. The direction, angle of approach, and wave size and shape vary from place to place, and with time or season, depending on the characteristics of prevailing and storm-related winds in the offshore areas and the refracting effects of bottom configuration as the waves approach the shore.

At certain times, depending on wave direction, littoral drift at a location may move to the north, while at other times the wave approach and resulting littoral drift may move to the south. The net balance of these opposing movements summed over a yearly period is referred to as the annual littoral drift. An area which has a zero net littoral drift is referred to as a nodal zone. Historically the nodal zone of zero net littoral drift on the New Jersey shore was thought to be located on the northern portion of the Barnegat barrier between Seaside Heights and Normandy Beach. Recent studies and analyses of long term trends around Barnegat Inlet indicate the nodal zone may shift as far south as Ship Bottom on Long Beach Island (S.D. Halsey, NJDEP, personal communication). As indicated in Figure I.C-8, the net littoral drift on the New Jersey Atlantic coast is to the north for the areas north of the nodal zone and to the south for the areas south of the nodal zone.

Operative littoral processes along the shorelines of the Raritan Bay, Delaware Bay, and coastal backbay areas include prevailing and storm-related wind-driven waves and currents and tidal currents. The general irregularities of these open and backbay shorelines are indicative of the lower average wave energies acting on them as compared to the ocean shoreline.

Predominant littoral processes acting on the shoreline of the Delaware River and navigable tidal tributaries around the coast of New Jersey include tidal currents, high tide levels associated with storms, and locally generated ship and boat wakes.

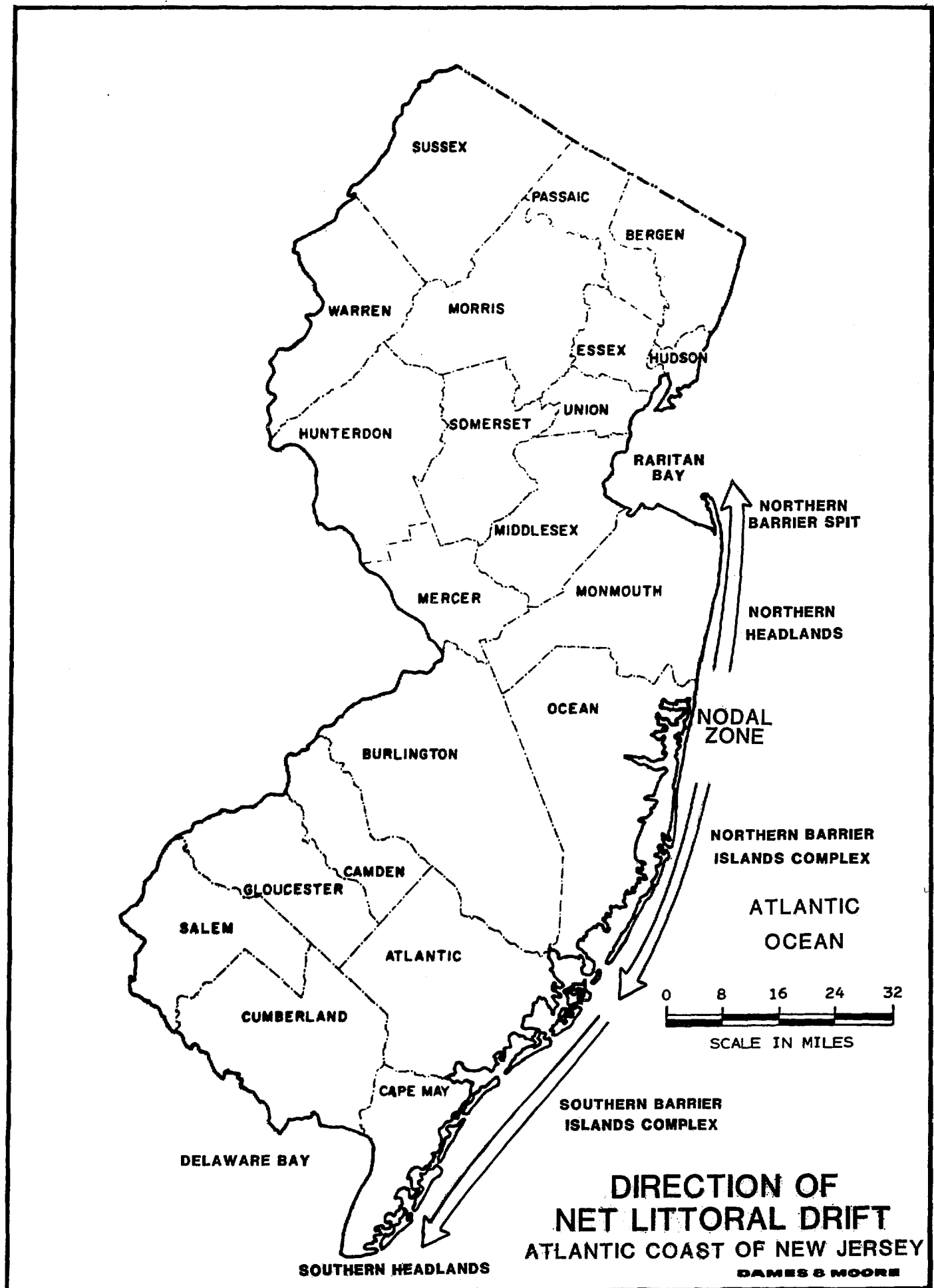


FIGURE I.C-8

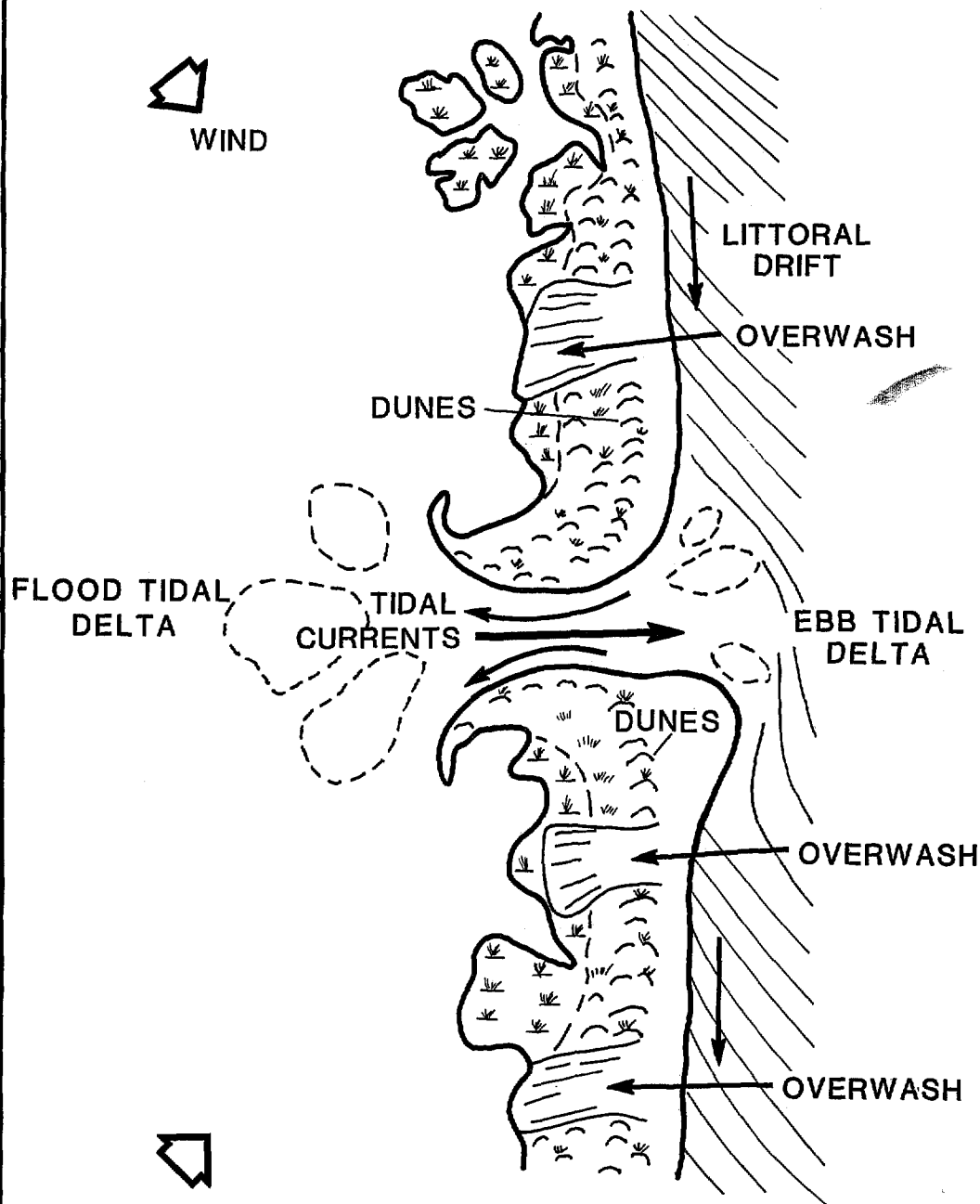
(3) Wind Effects. In addition to its influence on waves and the related effects of transport in the shore zone, wind is also important in the transport of sand above the high water line, where it contributes to dune formation and the transfer of sand along and between the dune and beach systems. Sand transport begins when the wind velocity reaches a certain threshold level which varies as a function of the sand grain size. Bagnold (1954) suggests that the basic threshold value for the initiation of sand movement by wind is approximately 14 ft/sec. or 10 mph. As the wind velocity increases beyond the necessary threshold level, so does the capacity of the wind to transport the sand (CCES, 1979). Substantial sand movement is only accomplished by sustained high wind velocities.

Over a given period of time, the total amount of sand transported in a particular direction is primarily dependent on the duration and direction of the wind. Other factors influencing sand transport in the beach and dune areas include rainfall, salt spray, drying, stabilizing vegetation, local topography, the degree of development, and human activities.

(4) Tidal Inlets. Tidal inlets, another major element of the coastal system (Figure I.C-9), are short, narrow waterways which hydraulically connect the backbays and estuaries with the open ocean. Natural inlet channels are primarily maintained by tidal currents, which help to prevent shoaling of the inlet. Inlets generally scour to a maximum depth in the area of greatest constriction, usually in the central part immediately between the barrier islands or land masses which contain them.

As illustrated on Figure I.C-9, broad shoals are common at the landward and seaward ends of the inlet. These shoals, known as tidal deltas, are formed by sand of the littoral drift system and the declining velocities of tidal currents. Ebb tidal deltas or shoals form in the offshore areas at the inlet mouth in response to deposition of sediment, and flood tidal deltas form on the bay side of the inlet from flood tidal currents. The ebb tidal shoals cause significant refraction, especially of waves from the east or northeast. This results in a reversal in net littoral drift from the general southerly net drift in the Southern Barrier Island Complex to a northerly net drift on the northern portions of the islands (Hayes, 1975; Dames & Moore, September 1974). This action and the movement of sand to the south around the outer edge of the ebb shoal result in the bulbous accretional configuration which characterizes the northern portion of most of these barrier islands.

As with barrier islands, the tidal inlets are in a state of "moving equilibrium" because tidal current flow, waves, and littoral drift are constantly changing. Depending on the combination of these coastal processes, inlets may remain stationary and open, closed, or migrate laterally. The migration of inlets is generally a one-directional movement, following the net littoral drift. In the migration process, the drift system deposits sediments on the updrift side of the inlet, causing the tidal currents to erode the downdrift side (Bruun, 1978). Several instances of such continuous lateral migration have been documented along the east coast of the United States. Lucke (1934) reported that Barnegat Inlet has migrated a significant distance south during the past century. Recent work at Fire Island Inlet, on Long Island, has revealed that the inlet has migrated west along the barrier for a total distance of 5 miles in the past 115 years (Kumar, 1972).



## MECHANISMS OF SAND TRANSPORT ON BARRIER BEACHES

REFERENCE: ADAPTED FROM GODFREY, 1976.

DAMES & MOORE

Due to changes in the equilibrium conditions, an established inlet may become constricted or closed completely by deposition of large quantities of littoral sediments. Such changes could be caused by increased littoral drift or by a reduction of tidal hydraulic pressures (Bruun, 1978). Conversely, an inlet may stabilize and remain at one location for a long time. Stabilizing factors could be natural, such as reduced drift, increased tidal flow, or an erosion-resistant downdrift shore, or artificial, such as dredging and jetty protection. The locations of existing and reported extinct inlets on the Atlantic coast of New Jersey are presented in Table I.C-4 and on Figures I.C-10 and I.C-11, respectively.

New inlets are commonly created and old inlets eliminated by intense storm-related changes in equilibrium conditions. Formation of a new inlet by breaching may result from one or a combination of the following:

- o Storm wave overtopping from the seaward side of the barrier.
- o Storm surge reflux on the landward side (a high storm water level in the backbay which drains out over low areas of the barrier).

Temporary, storm-changed hydraulic patterns accompanied by an increased littoral drift may result in closure of new inlets. Due to the continued dynamic conditions of the barrier system, the inlets eroded by storm conditions may remain as the tidal connections between the backbay and ocean, replacing the less hydraulically favorable inlets.

An example of the dynamic nature of an inlet system in response to littoral forces is provided by a study of the Beach Haven-Little Egg Inlet system (Dames & Moore, 1975; DeAlteris et al., 1976). Maps and charts dating to 1685 show varying configurations of a single and combined inlet system. In 1685, the Beach Haven Inlet was located about 14,000 feet north of its 1974 position (Figure I.C-12). The position recorded on a 1743 map located the inlet several thousand feet south of the 1685 position. U.S. Coast and Geodetic Survey Charts from 1840 show that the southern tip of Long Beach Island and the adjacent Beach Haven Inlet had migrated over 20,000 feet to the south by 1903, at which time the Beach Haven Inlet merged with the Little Egg Inlet to form "New Inlet." This configuration lasted until 1920 when Long Beach Island was breached once again in the vicinity of Holgate and began a new cycle of southerly migration. This migration was driven by the infilling of the channel on its northern margin by south-moving littoral drift. To maintain its hydraulic equilibrium, the inlet eroded its channel on the southern margin and thus migrated south by cut-and-fill processes. Such processes result in the complete reworking of the south segment of Long Beach Island with each cycle. The natural process of southerly migration of the inlet will continue until the dual inlet configuration comparable to the 1903-1920 position is reached. Once again the hydraulic shortcut will reoccur in the future, with breaching in the Holgate vicinity repeatedly initiating the cycle.

Other inlets on the New Jersey coast have fluctuated slightly from an average position, but have not migrated as extensively as the Beach Haven-Little Egg complex. This fluctuation of channel position, however, results in periodic erosion and accretion of the terminal segments of the barrier islands adjacent to the inlets. The historical variations for the Brigantine and Wreck Inlets to the south of Pullen Island are shown in Figure I.C-12.

The breaching of a new inlet can have a significant effect on littoral transport in the adjacent shoreline zones. Sediment normally transferred downdrift becomes trapped in the inlet system and is generally stored in the flood or ebb tidal

TABLE I.C-4

**EXISTING AND EXTINCT INLETS ON THE ATLANTIC COAST OF NEW JERSEY**  
 (Refer to Figure I.C-10 and I.C-11 for Inlet Locations)

<u>Inlet Name</u>	<u>Status</u>	<u>Remarks</u>
Navesink River Inlet	Closed	Sandy Hook was connected to the Highlands in 1835-1836. The river emptied directly into ocean. Inlet closed by railroad in 1856. Later broke through in 1896-1897. Closed artificially 1900-1901.
Shrewsbury River Inlet	Closed	Closed by railroad 1856.
Whale Pond Inlet	Closed	Closed naturally.
Elberon Pond Inlet	Closed	Closed naturally.
Brook (no name)	Closed	Seepage to beach.
Deal Lake Inlet	Closed	Seepage to beach.
Sunset Pond Inlet	Closed	Seepage to beach.
Wesley Inlet (Long Pond)	Closed	Seepage to beach.
Goose Pond Inlet	Closed	Seepage to beach.
Duck Creek Inlet	Closed	Seepage to beach.
Shark River Inlet	Open	Artificially maintained with jetties.
Silver Lake Inlet (Perch Pond)	Closed	Seepage to beach.
Three Corner Pond Inlet (Lake Como)	Closed	Seepage to beach.
Fresh Pond Inlet (Spring Lake)	Closed	Seepage to beach.
Sea Girt Inlet (Wreck Pond)	Closed	Seepage to beach.
Newberry Pond Inlet	Closed	Old mouth of Manasquan (Squan River).
Manasquan River Inlet	Open	Artificially maintained with jetties.
Metedeconk River Inlet	Closed 1755	
Kettle Creek Inlet	Closed	
Cranberry Inlet	Open 1750 Closed about 1812	Opposite Toms River at present north border of Seaside Heights Borough.

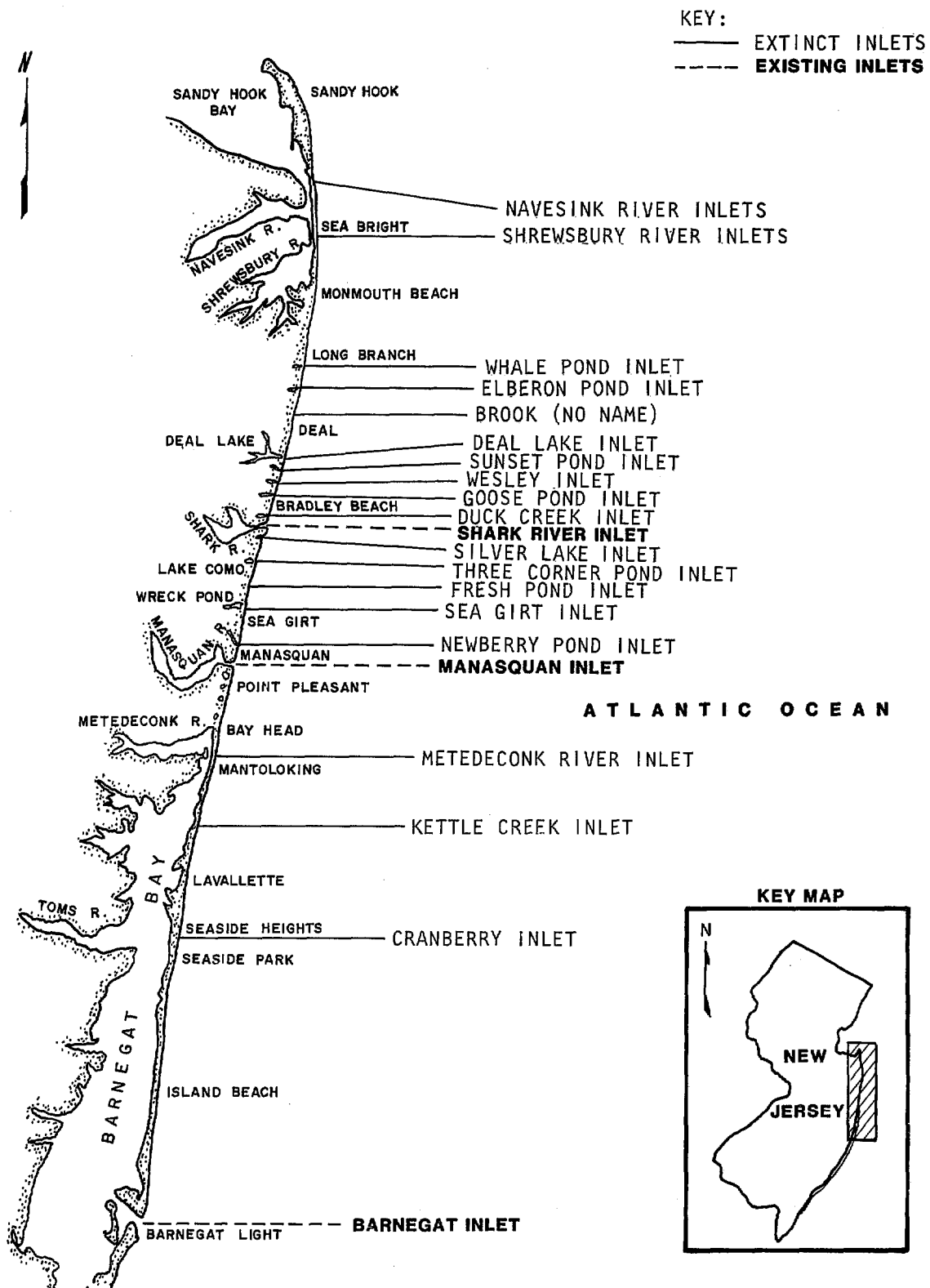
TABLE I.C-4 (Continued)

<u>Inlet Name</u>	<u>Status</u>	<u>Remarks</u>
Barnegat Inlet	Open	Artificially stablized by jetties. Presently being modified by COE.
Temporary Inlet Harvey Cedars	Closed	Island breached at Harvey Cedars by inlet during March 1962 storm. Closed by COE.
Temporary Inlet Holgate	Closed	Inlet breach at Holgate during March 1962 storm. Closed by COE.
Beach Haven Inlet Little Egg Inlet	Open	Highly migratory, not stabilized. Beach Haven and Little Egg Inlets merged about 1903 to form "New Inlet." In 1920, breach at Holgate reformed Beach Haven Inlet. Tuckers Island separated it from Little Egg Inlet. Tuckers Island steadily eroded to a shoal by 1953.
Wreck Inlet	Merged	Drained about 1905. Great Thorofare merged with Brigantine Inlet in 1963.
Brigantine Inlet	Open	Relatively stable in position since about 1840.
Brigantine Island Breach	Closed	1.5 miles north of Absecon Inlet in 1870.
Absecon Inlet	Open	Artificially stabilized.
Dry Inlet	Closed 1855	Absecon Island divided by shallow inlet at location of Jackson Avenue.
Great Egg Harbor Inlet	Open	Not stabilized.
Corsons Inlet	Open	Not stablized.
Townsend Inlet	Open	Artificially stabilized.
Hereford Inlet	Open	Artificially stabilized.
Turtle Gut Inlet	Closed	Located approximately 2 miles north of Cold Springs Inlet. Closed naturally in 1909. Later closed artificially 1917.
Cape May Inlet (Cold Springs Inlet)	Open	Artificially stabilized with jetties constructed during the 1908-1911 period.

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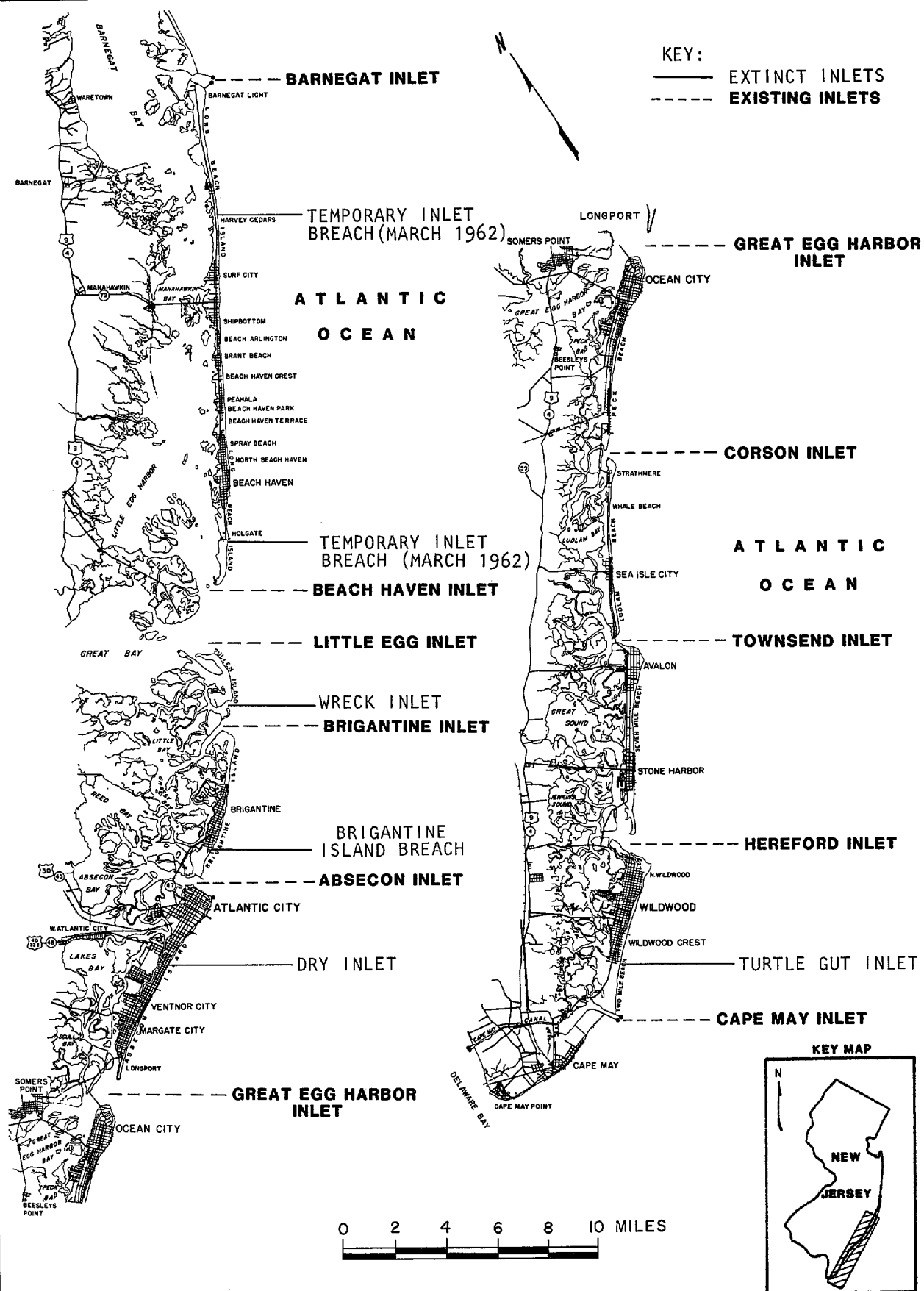
**Sources:**

Moss (1964); Lucke (1934); Dames & Moore (September 1974); State of New Jersey Board of Commerce and Navigation (1922).



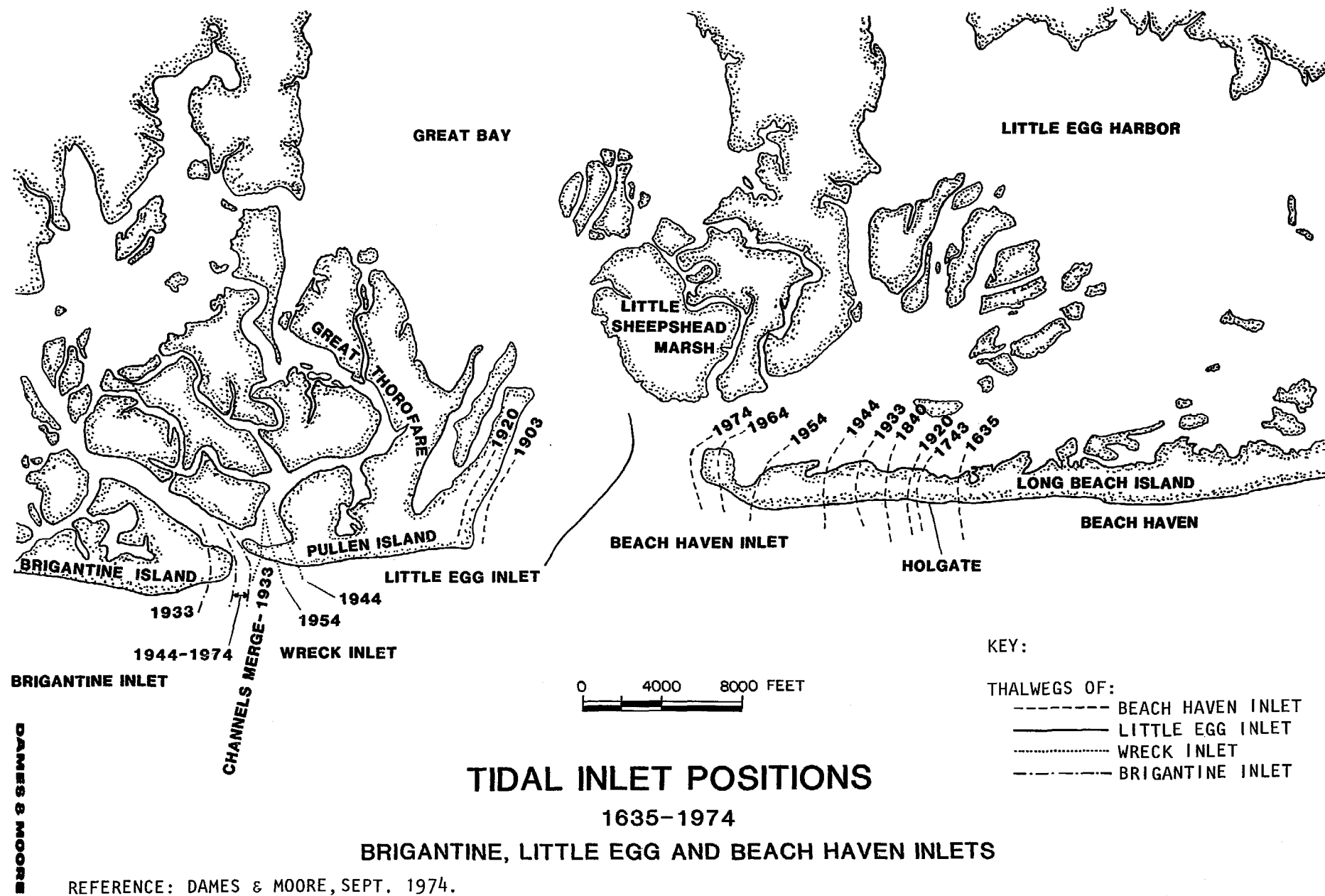
# EXISTING AND EXTINCT INLETS SANDY HOOK TO BARNEGAT INLET

DAMES & MOORE



# **EXISTING AND EXTINCT INLETS BARNEGAT INLET TO CAPE MAY POINT**

**DAMES & MOORE**



shoals. Changes in adjacent updrift shores usually accompany the formation of new inlets. Similarly, the artificial stabilization of existing inlets (e.g., Shark River, Manasquan, and Cape May Inlets) with structures, such as jetties, or through repeated maintenance dredging typically results in the entrapment or removal of littoral drift materials that would normally pass into and through the natural inlet system. Although inlet stabilization reduces channel infilling and the need for inlet maintenance dredging to some degree, it may also result in downdrift littoral starvation and subsequent shoreline erosion.

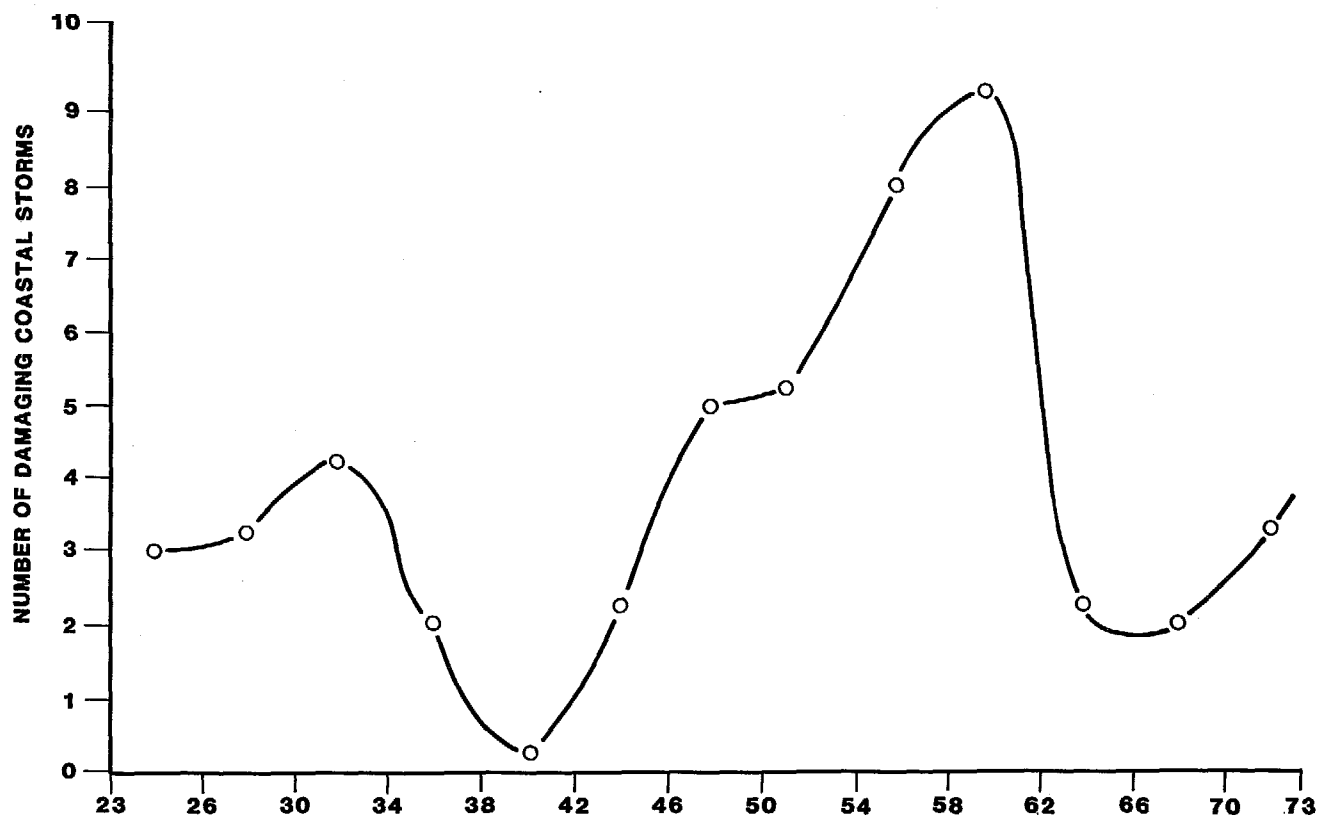
Shore areas adjacent to the inlets thus represent highly transitory areas due to inlet dynamics. Where inlets of the Southern Barrier Island Complex have been artificially stabilized with terminal and shore protection structures, the shores are continually subject to erosion caused by the dynamic fluctuations of the inlet system. In particular, the southern shore of each inlet is a persistent problem area because erosion threatens inlet and shore stabilizing structures and the developed areas behind them.

(5) Coastal Storms. The most dramatic example of the effect of the dynamic forces of nature on the shore zone is the impact of severe storms. Hurricanes and northeasters traveling along the New Jersey coast have damaged beaches and shore development throughout recorded history. Since 1900, the Atlantic and Gulf coast barrier islands have been affected by more than 100 hurricanes. Although hurricanes account for most of the damage along the New Jersey coast, 35 to 40 winter storms (northeasters) each year have enough force to erode beaches (Hayden, 1975).

Mather and others (1964) have classified storms for the east coast of the United States according to the extent of coastal damage (light, moderate, and severe) from 1921 to 1962. New Jersey recorded 25 light, 26 moderate, and five severe storms for this period, with an average recurrence interval for moderate and severe storms of one every 1.4 years. This recurrence interval is low compared to other coastal sectors, indicating a lower frequency of damaging storms. Mather and others point out that once in every 30 years, a very severe storm will bring extensive damage not only to a particular area but to the entire coast.

Figure I.C-13 illustrates the number of damaging coastal storms for the east coast as shown by the variation in the 4-year running average (3-year average for 1970 to 1973 period). This figure is compiled from Mather and others (1964) for the period up to 1962 and from Richardson (1977) for the period from 1962 to 1973. Because Richardson's data exclude hurricanes or extratropical storms in the March through October period, hurricane occurrences were added to provide a data base comparable to that of Mather and others (1964). Figure I.C-13 illustrates a general cyclical pattern to the frequency of damaging coastal storms, with low frequency periods from 1938 to 1942 and 1964 to 1968. The increased winter storm activity of 1977 to 1979, including Hurricane David in 1979 and the blizzard of 1978, may represent the beginning of a period to be characterized by an increased frequency of damaging storms comparable to that of the late 1950's to early 1960's. The last major hurricane to hit the Atlantic coast was Donna in 1960; thus, less than 20 percent of the residents of the Atlantic coast have ever experienced the impact of such a severe storm (Dolan et al., 1980).

In light of the nature of coastal development and the characteristics of coastal surges from hurricanes and northeasters, structures located directly along the beach and properties landward of these areas are subject to a high risk of damage from floating debris carried inland by storm surges.



**NUMBER OF DAMAGING COASTAL STORMS  
EASTERN UNITED STATES  
(4 YEAR AVERAGE-1923 TO 1973)**

REFERENCE:

1923 TO 1962 MATHER ET AL.(1964);  
1962 TO 1973 RICHARDSON (1977)

NOTE: 1970-1973 IS A THREE YEAR AVERAGE.

The great northeaster of March 6-8, 1962, is an example of the severest type of storm along the mid-Atlantic coast (Mather et al., 1964). It was a complex, unexpected storm of sustained direction and intensity, combined with high spring tides. Although the water level was generally higher during the September 1960 hurricane (Donna), the storm of March 1962 was more widespread and inflicted substantially greater overall damage and loss of life. This was primarily due to its duration — the damaging high waters and destruction waves generated by gale force winds occurred on five successive high tides over a period of 2 days. Each succeeding tide had less beach or dune or bulkhead to dissipate its force and could reach farther inland, until in some cases the sea was able to cut completely through the barrier islands (USACOE, Philadelphia District, August 1963).

The damages resulting from the 1962 storm were unequalled by any storm in history along the New Jersey coast. In New Jersey alone, the storm was responsible for killing 14 persons and injuring more than 1300. Property damages in New Jersey exceeded \$120 million (1962 dollars). A summary of fatalities, injuries, and estimated property damages is presented in Tables I.C.5 and I.C.6. The intensity of damage along the New Jersey coast is illustrated in Figures I.C-14 through I.C-19.

Unfortunately, the devastation of the March 1962 storm was soon forgotten, and population and development have continued to increase in shore areas, much of it within the actual overwash zones of the storm. Since present population and development levels of the State's barrier islands exceed pre-1962 levels, future severe storms will undoubtedly result in far heavier tolls in lives, injuries, and property damage.

The demand for oceanfront properties directly on barrier islands or onshore areas with ready access to beaches remains high, despite the history of hurricanes, northeasters, and other storms, the costly damages, and the inevitable risk. This holds true for the time prior to and since Federal flood insurance became available to New Jersey residents living in coastal flood hazard areas.

(6) Sediment Sources and Budget. Potential sources of sand for supply to the littoral drift system of a coastal area include: (1) river sediment supplied to the coast, (2) material eroded from coastal cliffs or headlands, and (3) material from within the barrier island (especially from the beach, dune, and shoreface areas). For the New Jersey coast, no riverborne sediment is supplied to the shoreline. Due to the low gradient of the coastal plain and the flooding of estuaries and bays as a result of the sea level rise since the last glacial ice age (Wisconsin Age) some 15,000 years ago, sediment reaching the nearshore area is fine grained and is trapped in the bays, lagoons, and estuaries. Thus, the only significant natural sand sources for the New Jersey shore are the headlands and the front (seaward) edges of the barrier islands (Figure I.C-20).

The erosion of the front edge of the barrier (shoreface erosion), together with the transport of sediment in the system to the interior of the barrier through deposition in flood tidal shoals and overwash deposits, result in the constant recycling of the barrier sediment from front to back and the gradual migration of the barrier island toward the mainland. Evidence of this process is the discovery of peats, tree stumps, and other remnants of backbarrier deposits on the ocean beaches (Kraft et al., 1976; Fisher and Simpson, 1979). In addition, this pattern of migration can be measured from historical shoreline maps and aerial photographs.

**TABLE LC-5**  
**NEW JERSEY FATALITIES, INJURIES, AND ESTIMATED PROPERTY DAMAGE**  
**DUE TO THE MARCH 1962 STORM**

<u>Category</u>	<u>Ocean County</u>	<u>Atlantic County</u>	<u>Cape May County</u>	<u>Cumberland County</u>	<u>Monmouth County</u>	<u>Totals</u>
Killed	5	4	0	2	3	14
Minor injuries	86	237	545	190	12	1,070
Major injuries	9	85	127	9	3	233
Hospitalized	8	9	72	9	1	99
Dwellings destroyed	267	24	634	5	2	932
Dwellings - major damage	907	243	2,519	6	11	3,686
Dwellings - minor damage	11,749	13,453	19,811	52	500	45,565
Other buildings destroyed	128	0	82	0	5	215
Other buildings - major damage	0	0	0	0	3	3
Other buildings - minor damage	253	854	814	4	0	1,925

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**Source: USACOE, Philadelphia District (August 1963)**

TABLE I.C-6

**SUMMARY OF ESTIMATED 1962 STORM DAMAGES IN NEW JERSEY**  
(in thousands of dollars at 1962 price levels)

Damage Category	Location							Totals
	Ocean County	Atlantic County	Cape May County	Cumberland County	Northern N.J. Inland Tidal Areas	Raritan and Sandy Hook Bays (Middlesex & Monmouth Co.)	Sandy Hook to Manasquan Inlet (Monmouth Co.)	
Residences and contents (private)	\$16,218	\$ 14,241	\$ 27,814	\$ 75	\$ 311	\$ 2,580	\$ 1,240	\$ 62,479
Commercial buildings and contents (private)	1,416	7,613	6,387	22	992	1,000	229	17,659
Public property (Federal, State or local installations)	1,963	552	2,007	—	538	140	575	5,775
Roads, bridges, railroads	1,304	614	1,332	—	91	5	7	3,353
Boats	169	87	51	—	7	180	161	655
Utilities losses	528	358	1,050	—	21	120	83	2,160
Wharves, docks, piers, bulkheads	116	—	—	—	—	—	—	116
Protective shorefront bulkheads, seawalls, groins, jetties	231	566	1,976	—	9	75	900	3,757
Boardwalks	207	979	1,818	—	—	—	375	3,379
Beaches and dunes	7,413	2,100	2,755	—	10	1,400	4,000	17,678
Navigation channels	200	—	—	—	—	—	—	200
Other losses	342	1,121	1,527	—	1,045	900	600	5,535
<b>Totals</b>	<b>\$30,107</b>	<b>\$ 28,231</b>	<b>\$ 46,717</b>	<b>\$ 97</b>	<b>\$ 3,024</b>	<b>\$ 6,400</b>	<b>\$ 8,170</b>	<b>\$122,746*</b>

\*When inflated to 1980 dollars, this amount represents approximately \$334 million in damages.

Source: USACOE, Philadelphia District (August 1963).



(REACH 7) LOVELADIES, LONG BEACH TOWNSHIP, LONG BEACH ISLAND, MAR. 9, 1962, LOOKING NORTH

REFERENCE: USACOE, PHILADELPHIA DISTRICT, AUGUST 1963



(REACH 7) STORM BREACH AT HARVEY CEDARS, LONG BEACH ISLAND

REFERENCE: USACOE, PHILADELPHIA DISTRICT, AUGUST 1963



(REACH 11) SEA ISLE CITY, LUDLAM BEACH, MAR. 9, 1962

REFERENCE: USACOE, PHILADELPHIA DISTRICT, AUGUST 1963



(REACH 11) WHALE BEACH, UPPER TOWNSHIP, LUDLAM BEACH, MAR. 9, 1962  
(NOTE HOMES WASHED INTO BACKBAY WETLANDS)

REFERENCE: USACOE, PHILADELPHIA DISTRICT, AUGUST 1963



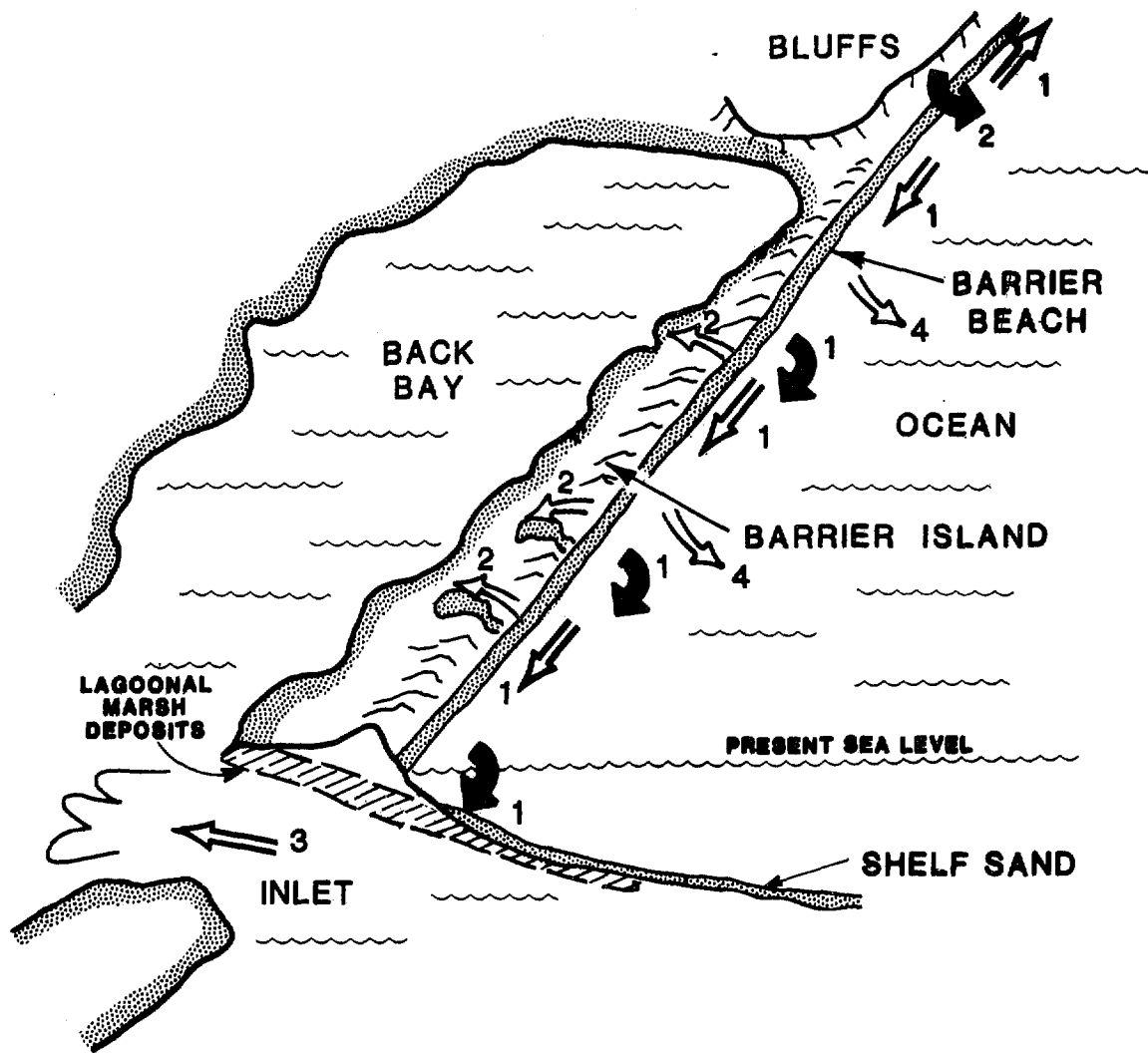
(REACH 7) AERIAL VIEW OF OVERWASH OF LONG BEACH ISLAND  
AFTER THE MARCH 1962 STORM. NOTE HOMES WASHED INTO BACKBAY

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(REACH 12) 1962 STORM DAMAGE AT AVALON

REFERENCE: USACOE, PHILADELPHIA DISTRICT, AUGUST 1963



## SCHEMATIC DIAGRAM OF COASTAL SEDIMENT BUDGET

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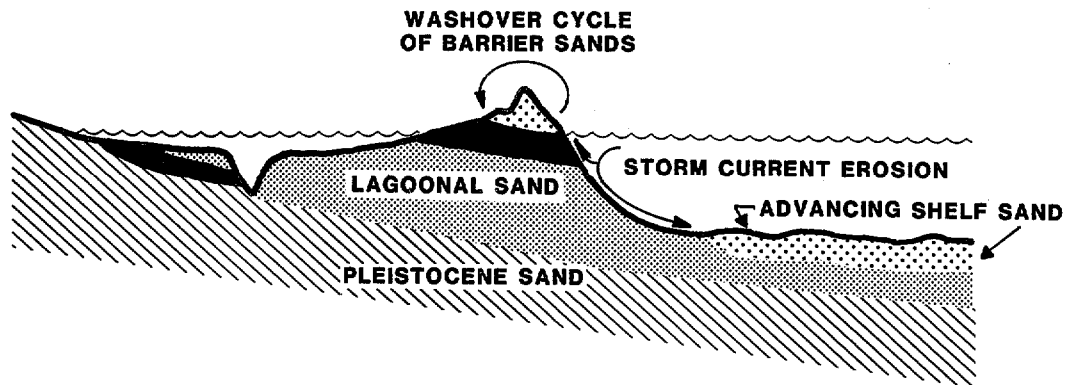
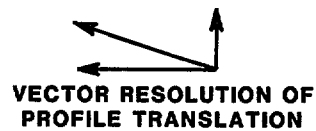
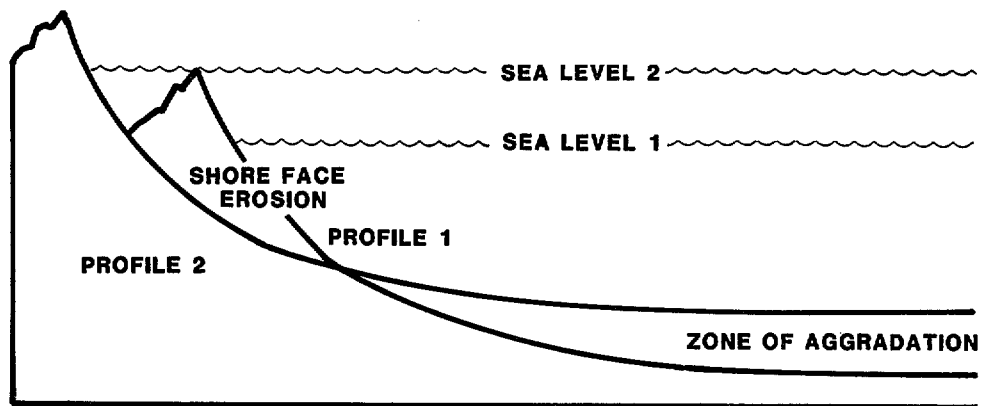
(7) Sea Level Rise. Barrier island migration and shoreface erosion is further compounded by the continued and gradual sea level rise which has been occurring since the melting of the glaciers at the end of the Wisconsin Age. Geologic evidence suggests that about 35,000 years ago, sea level may have been near its present level. During the peak of the Wisconsin glacial stage, about 15,000 years ago, water held in glaciers is believed to have been responsible for worldwide lowering of sea levels by 300 to 350 feet (Kraft, 1971) and possibly even by 430 feet (Milliman and Emery, 1968). This exposed a broad expanse of gently sloping continental shelf which, at that time, formed a low coastal plain. The shoreline was at the edge of the continental shelf, some 80 to 100 miles east of the present-day coast.

Bruun (1962) developed the concept that the characteristic exponential curve of the shoreface profile represented an equilibrium response to the prevailing hydraulic climate along the shore. As sea level rises, the equilibrium shoreface profile is translated upward and shoreward (Figure I.C-21). Erosion of the shoreface supplies the littoral zone with material necessary to maintain equilibrium profiles. In addition, material is transferred offshore; as transgression occurs, the blanket of sand which covers the continental shelf surface is formed.

Measurements of tide levels along the coastal United States for the period from 1940 to 1970 indicate that relative sea level is still rising. Figure I.C-22 illustrates the rise in sea level for three stations in the area — New York City at the Battery, Sandy Hook, and Atlantic City. The general trend over the last 30 years has been a level rise of about 1 foot per century. The somewhat greater rise at Sandy Hook may in part reflect land subsidence due to compaction of the coastal sediment (Yasso and Hartman, 1975). Yearly variations are significant in these data and reflect the influence of climatic changes, such as seawater density variations as a function of the amount of runoff for a coastal area.

Periods of high river discharge and areas characterized by high discharges have higher sea levels (Meade and Emery, 1971). The high erosion rate for the Headland segments of New Jersey, which have recessed relative to the adjacent coastal segments, may be related to an ambient sea level which is somewhat higher in these zones than in adjacent areas. These locally higher seas can be inferred from the fact that the headland areas are located adjacent to the coastal waters which receive the fresh water discharge plumes of major estuaries. The plumes emerge onto the continental shelf and are driven to the south by the general southerly drift of the coastal currents. The Hudson plume emanates from the Lower Harbor and tends to spread along the northern New Jersey shore area. These fresh water lobes, when pushed onto shore by coastal storm winds, would result in even higher local seas and in more extensive erosion due to their higher level of impact on the shore. Since the possibility of such local sea level effects on the patterns of shore erosion has not been systematically researched, it is largely an untested theory. However, these effects may be as important or even more important than the generally held concept that wave energy concentration in these zones, as a result of wave refraction effects, causes the high erosion.

The concept that increased sea level can be equated to increased erosion and littoral drift is suggested in the studies of beach and shoreline change in the vicinity of Beach Haven and Little Egg Inlets, discussed earlier (Dames & Moore, September 1974; DeAlteris et al., 1976). These studies demonstrated a close correlation between the rate of migration of the Beach Haven Inlet and the rise in sea level for the period from 1952 to 1972. The implication of this correlation is that periods of higher sea level resulted in greater erosion of the beach profiles, supplying

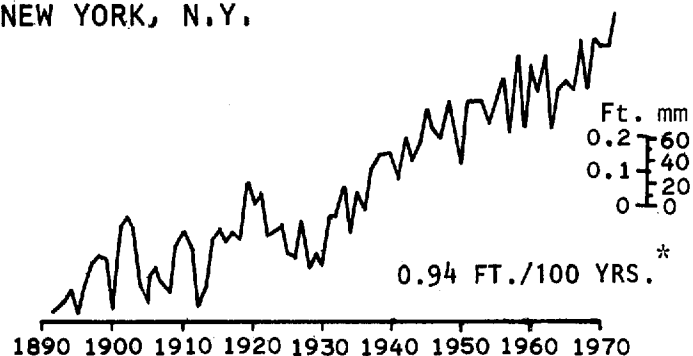


## BRUUN'S CONCEPT OF SHORE FACE EROSION DUE TO SEA LEVEL RISE

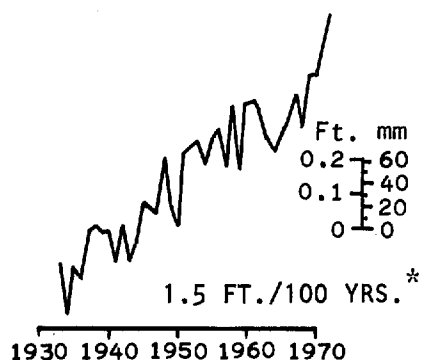
REFERENCE: AFTER STANLEY AND SWIFT, 1976.

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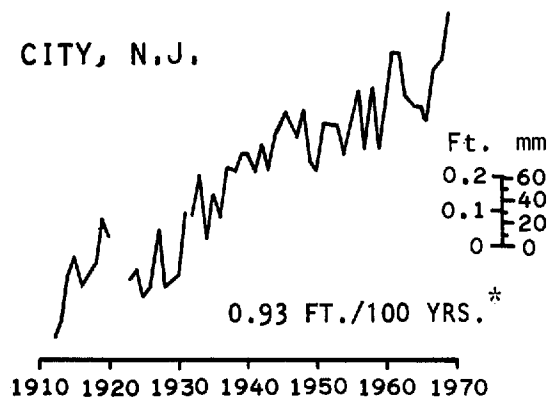
# NEW YORK, N.Y.



# SANDY HOOK, N.J.



# ATLANTIC CITY, N.J.



## YEARLY MEAN SEA LEVELS RELATIVE TO THE LAND

(\*) 1940 - 1970 TREND

REFERENCE: HICKS (1972) AND SWANSON (1976)

**DAMES & MOORE**

more material to the littoral drift, which in turn caused more rapid infilling of the inlet on its northern margin and the greater rate of inlet migration to the south. Thus, it would appear that areas such as the Northern Headlands, which appear to be characterized by higher sea levels than adjacent areas, may actually have higher rates of erosion over a long period of time.

Bluff and shoreface retreat (erosion) are integral parts of the dynamics of the shoreline system. As this retreat takes place it supplies the beach and nearshore areas with the sediment necessary to maintain equilibrium profiles in balance with the wave climate.

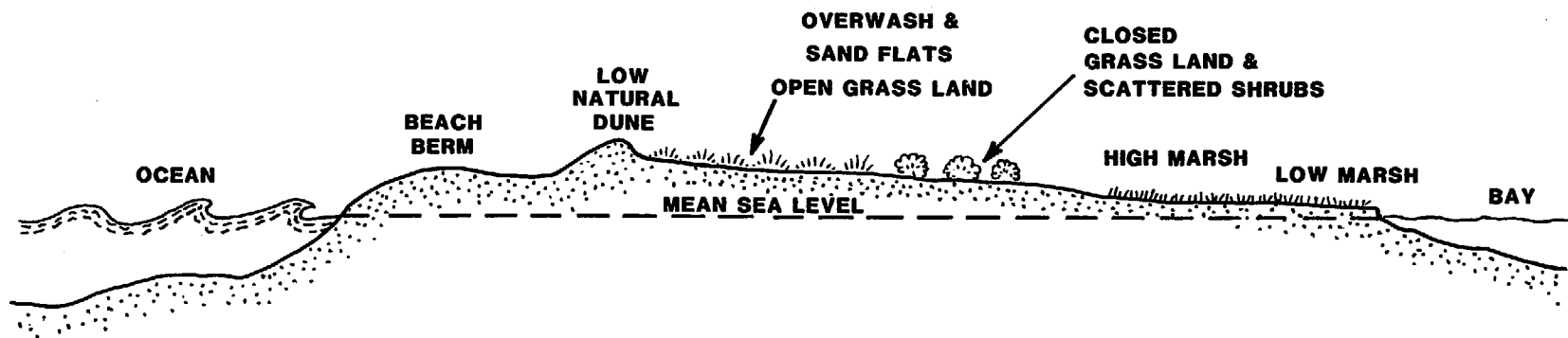
c. Beach Erosion — the Natural (Dynamic) and the Stabilized Shoreline Cases

In the natural system, where the internal sources of sediment for littoral drift are obtained by bluff retreat and barrier island migration, the translation of the shore profile in the landward direction occurs uniformly with no oversteepening or degradation on components of the profile. The beach at the toe of a bluff after retreat is the same width and slope as the earlier beach, but in a new location. The barrier island is uniquely designed to withstand storm flooding, overwash, and sea level rise and to maintain its overall profile without oversteepening or loss of the beach or nearshore profile.

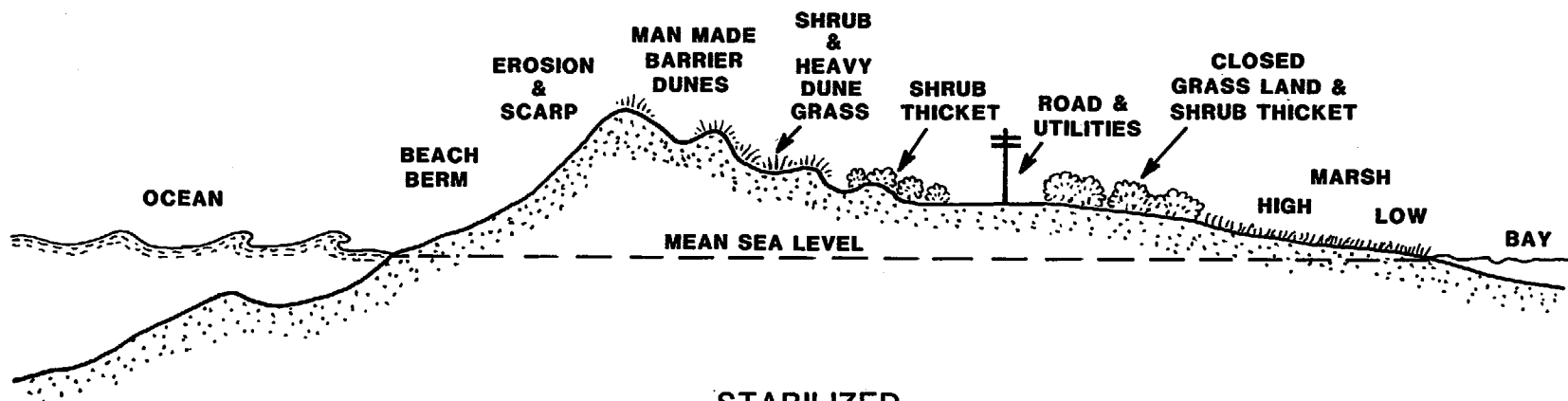
Studies supported by the National Park Service on the North Carolina barrier islands have clearly demonstrated the inherent advantage of the natural system in this regard (Dolan et al., 1973; Godfrey and Godfrey, 1973b; and Dolan and Godfrey, 1973). The profiles from a natural barrier, Core Banks, were compared with those from a barrier stabilized by development of manmade sand dunes at the Cape Hatteras National Seashore. Comparisons were made before and immediately after a major storm event, Hurricane Ginger, which struck the area on September 20, 1971. The natural barrier profile at Core Banks consists of a wide flat berm and low dunes, while at Hatteras, the dunes are high and stabilized with scrub growth in areas where natural sand flats previously occurred (Figure I.C-23). The overall effects of Hurricane Ginger were an increase in land elevation and general maintenance of the barrier profile on Core Banks and the severe erosion of the beach face at Hatteras. The Core Banks profile allowed the dissipation of the storm surge and wave effects across the whole profile, flattening of the beach face, and transportation across the dunes to overwash areas. In contrast, at Hatteras, the manmade dunes absorbed the full impact of the surge and waves and eroded rapidly, since the runup profile was restricted to the narrow beach face. The sands were transferred alongshore and offshore out of the system — not inland as at Core Banks.

Manmade barriers and attempts at maintaining a static shoreline position, either through impenetrable stabilized dunes, as at Hatteras, or through use of shore protection structures, result in the oversteepening of the profile and eventual loss of the beach. These effects are due to a sand budget deficit in the system. More energy is available than can be expended in moving materials through the littoral system. The natural system responds by island and bluff migration but not at the expense of the beaches (Figures I.C-24 and I.C-25). Where a static system is sought, the man-modified system must pay the price of continual resupply of the beach area.

Thus, beach erosion as a problem exists only where development has taken place, and where man has adversely affected the natural sand supply and attempted to impose a static shoreline. In the long run, the rising sea and wave forces will not cooperate (Figure I.C-26).



NATURAL

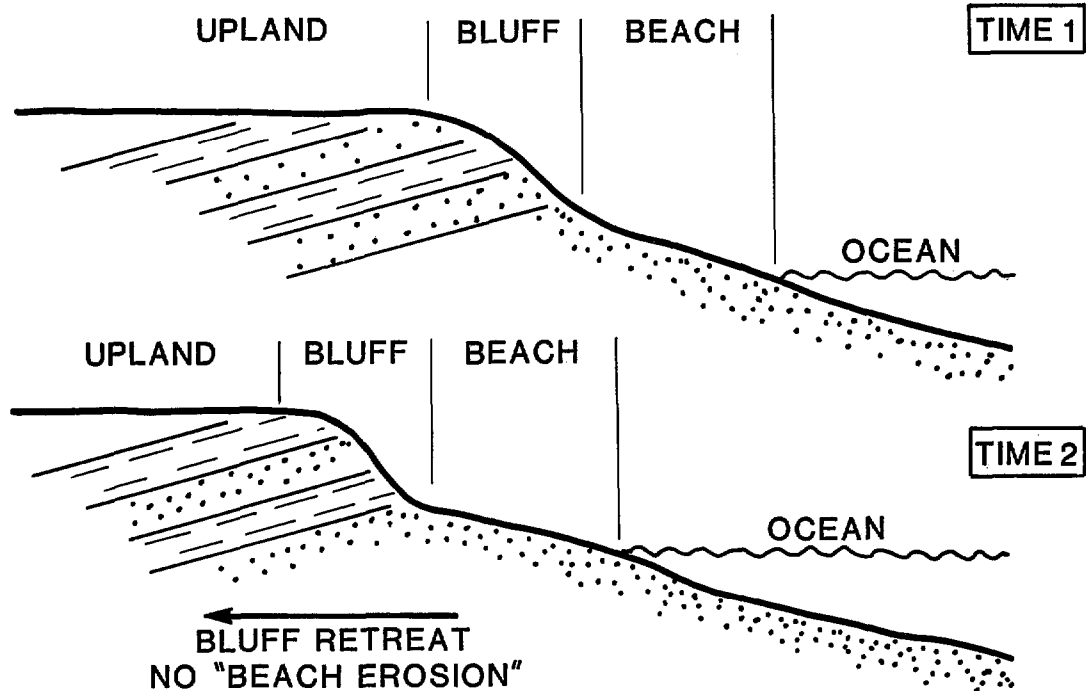


STABILIZED

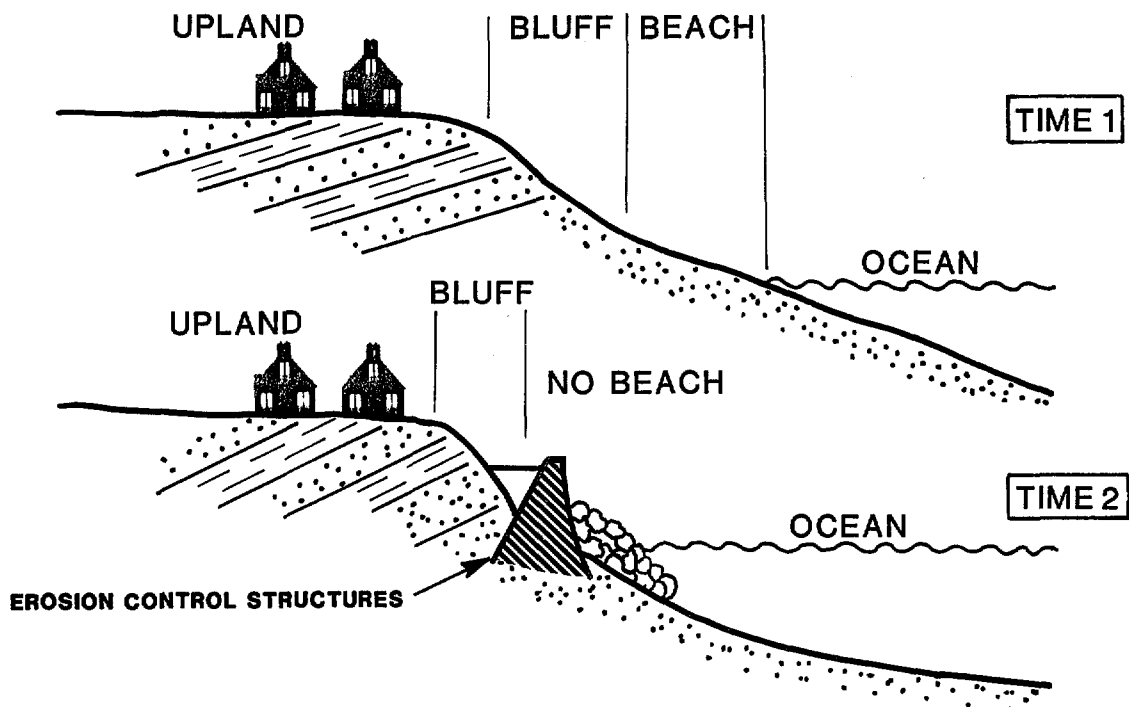
## NATURAL AND STABILIZED BARRIER ISLANDS

REFERENCE: AFTER DOLAN ET AL, 1973

## NATURAL BLUFF OR HEADLAND SYSTEM



## DEVELOPED BLUFF SYSTEM

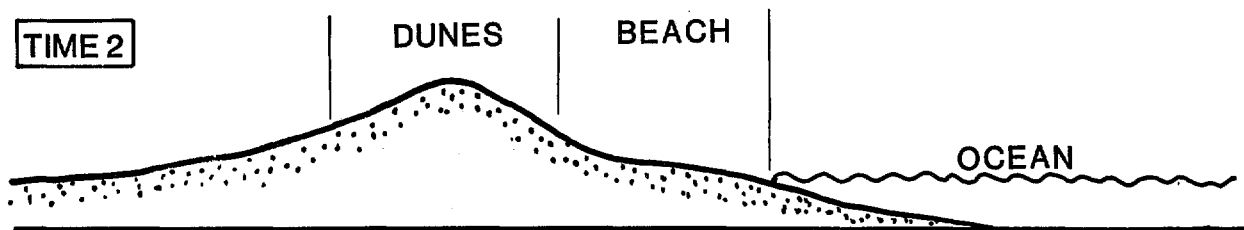
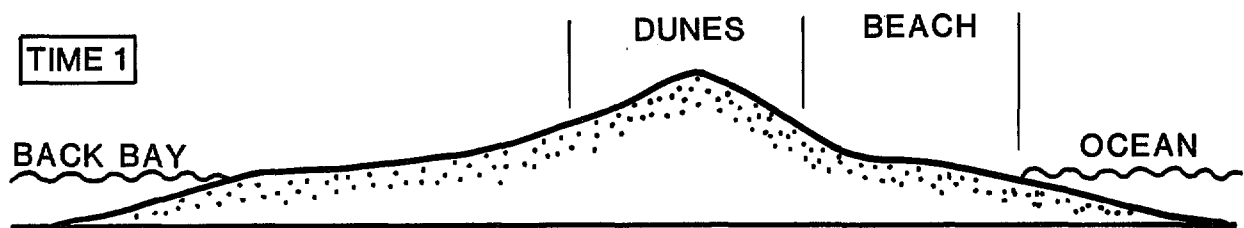


## NATURAL VS. DEVELOPED BLUFF OR HEADLAND SYSTEM

REFERENCE: AFTER NORDSTROM ET AL, 1977.

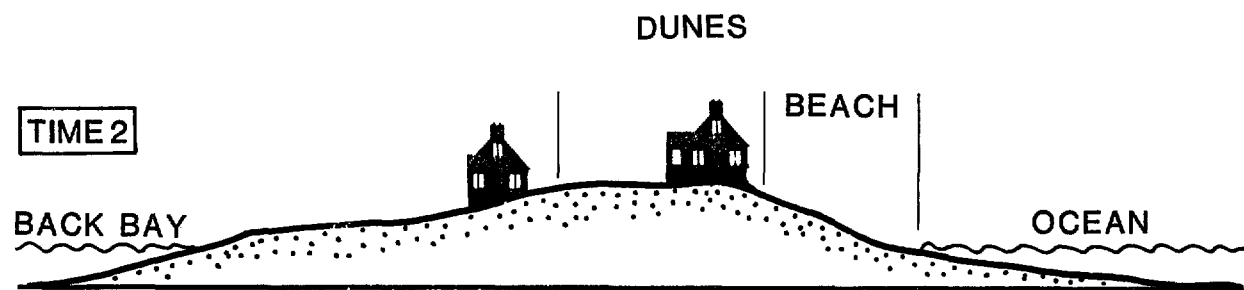
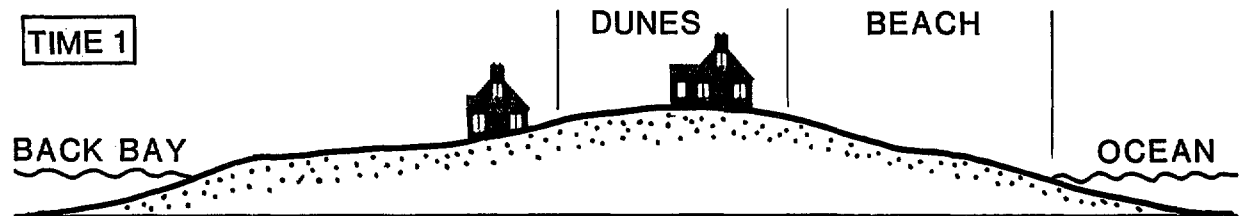
DAMES & MOORE

## NATURAL BARRIER SYSTEM



ISLAND MIGRATION  
←  
NO "BEACH EROSION"

## DEVELOPED BARRIER SYSTEM

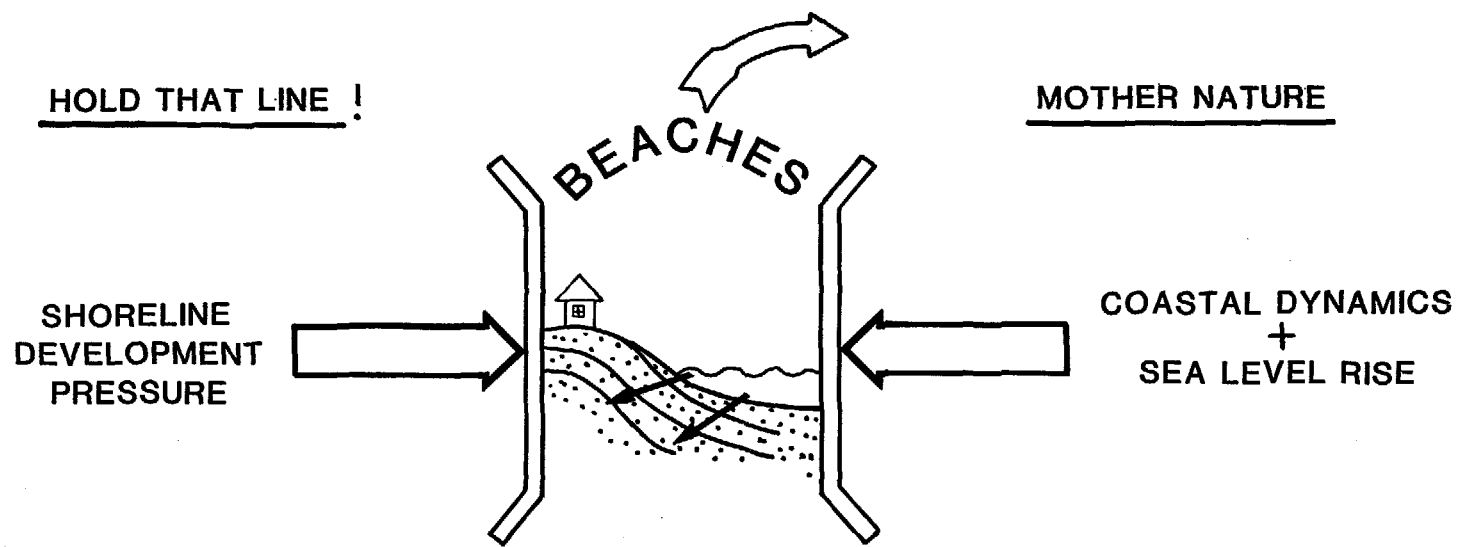


"BEACH EROSION"

## NATURAL VS. DEVELOPED BARRIER SYSTEM

REFERENCE: AFTER NORDSTROM ET AL, 1977.

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## SHORE RESOURCE EFFECTS

- LOSING BEACHES
- NATURAL ECOSYSTEM IMPACTS
- LOSING NATURAL PROTECTIVE ASPECTS OF DUNE/BEACH SYSTEM

#### 4. Socioeconomic Setting

New Jersey's bay and ocean shore areas are extremely important economic assets and constitute unique social environments characterized by their seasonality and dependence on the tourism and resort industry. The economic and social importance of the coast is shown by the fact that in 1978 the Atlantic coast communities contained only 5.65 percent of the State's estimated population, but accounted for 8.4 percent of the State equalized value of real property. The population density for oceanfront communities from Sandy Hook to Cape May Point (Reaches 2-14) was estimated at 1,480 persons per square mile, as compared to the State average of 980 persons per square mile. The impact and importance of tourism on the coastal communities is reflected in the presence of several significant, seasonally based socioeconomic indicators. These include significant seasonal population and seasonal employment fluctuations, and a sizable seasonal housing component.

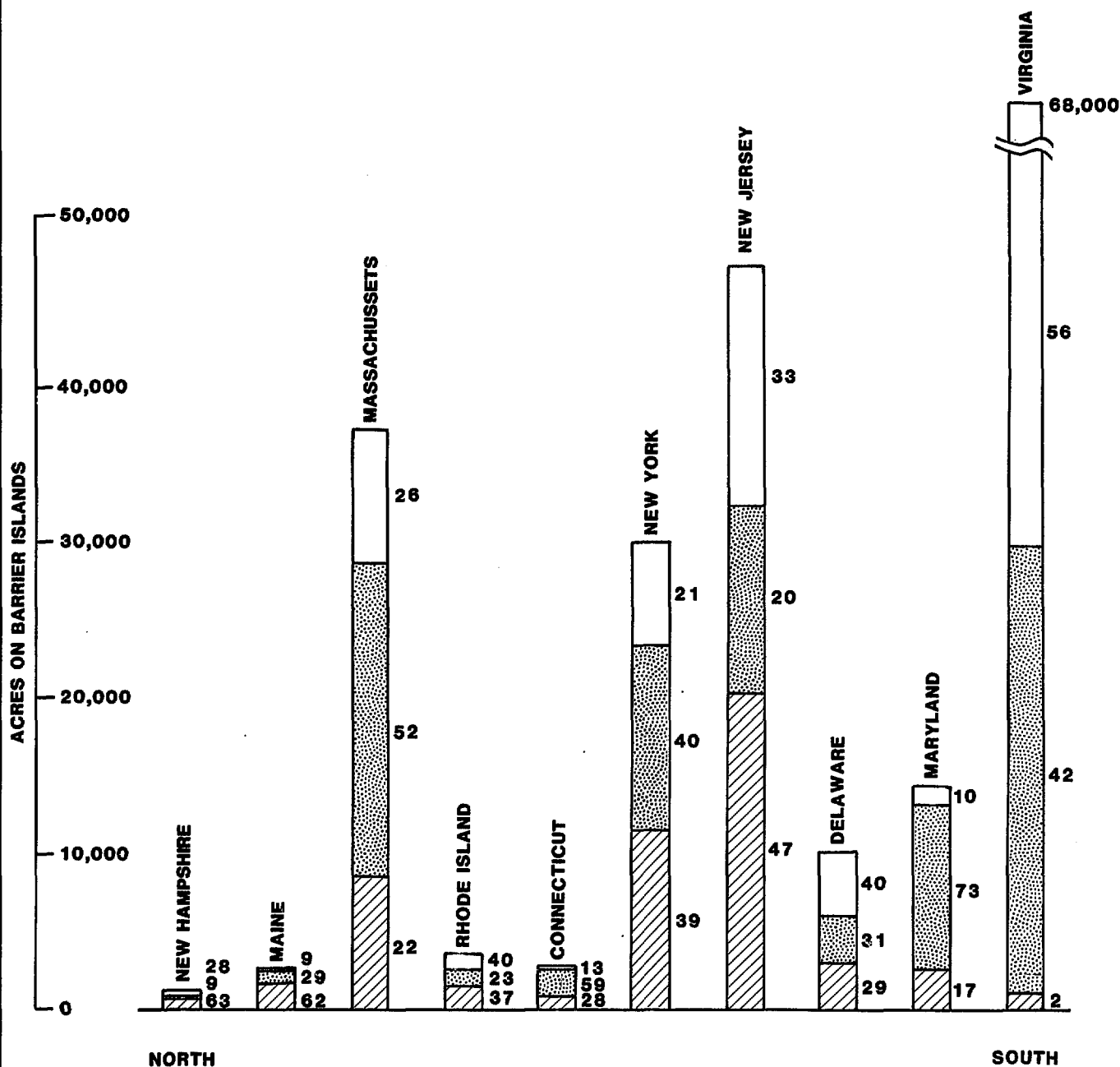
Figure I.C-27 shows the degree of development of New Jersey barrier islands as compared to barrier islands in adjacent New England and Mid-Atlantic states using the coarse data developed by the Heritage Conservation and Recreation Service (January 1980). Forty-seven percent of the total acres in New Jersey's barrier islands is classified as developed, slightly above the east and gulf coast average of 46 percent. What is significant is that only 20 percent of the acreage of New Jersey's barrier islands is classified as protected (e.g., parks, wildlife preserves, and conservation areas), lower than for any other adjacent state's barrier islands except New Hampshire's.

Figure I.C-28 provides the same breakdown for all of New Jersey's barrier islands. As expected, those barrier islands with substantial park areas are immediately recognizable. For example, Island Beach State Park is located in Reach 6 (Mantoloking to Barnegat). Some of the more recreationally-oriented reaches, such as Absecon Island (Reach 9), Peck Beach (Reach 10), and Long Beach Island (Reach 7), have fifty percent or more of their acreage classified as developed.

The tourism sector makes a major contribution to the State's economy. Most of this economic activity is concentrated in the four Atlantic coast counties. The concentration in these counties is shown by the fact that the trade (retail and wholesale) and service sectors accounted for 48.7 percent of the total labor and proprietor's income in the four Atlantic coast counties, as compared with 27.7 percent for the entire State (New Jersey Department of Labor and Industry, October 1979). This concentration is further shown in that employment in the above four counties, in the trade and service sectors, was 51.6 percent of total non-farm wage and salary employment, as compared to 41 percent statewide. (New Jersey Department of Labor and Industry, October, 1979).

The total amount of travel expenditures in New Jersey in 1976 was estimated at \$2.97 billion (U.S. Travel Data Center, 1976). This figure excludes day trips to destinations within 100 miles of home. Considering the significant proportion of day trips to the Ocean and Monmouth County beaches, this figure can be viewed as a minimum estimate of tourism expenditures in New Jersey. It is likely that most of this travel expenditure can be attributed to the resort economy, which is concentrated in the four Atlantic coast counties.

As a final indicator of the concentration of tourism economic activity in these counties, a comparison was made between median household effective buying income (MHEBI), which is essentially an approximate measure of disposable incomes as



KEY:



DEVELOPED



PROTECTED (PARKS, PRESERVES, ETC.)



UNPROTECTED/ UNDEVELOPED

52 % OF TOTAL STATE ACREAGE

EAST AND GULF COAST AVERAGES

46% DEVELOPED

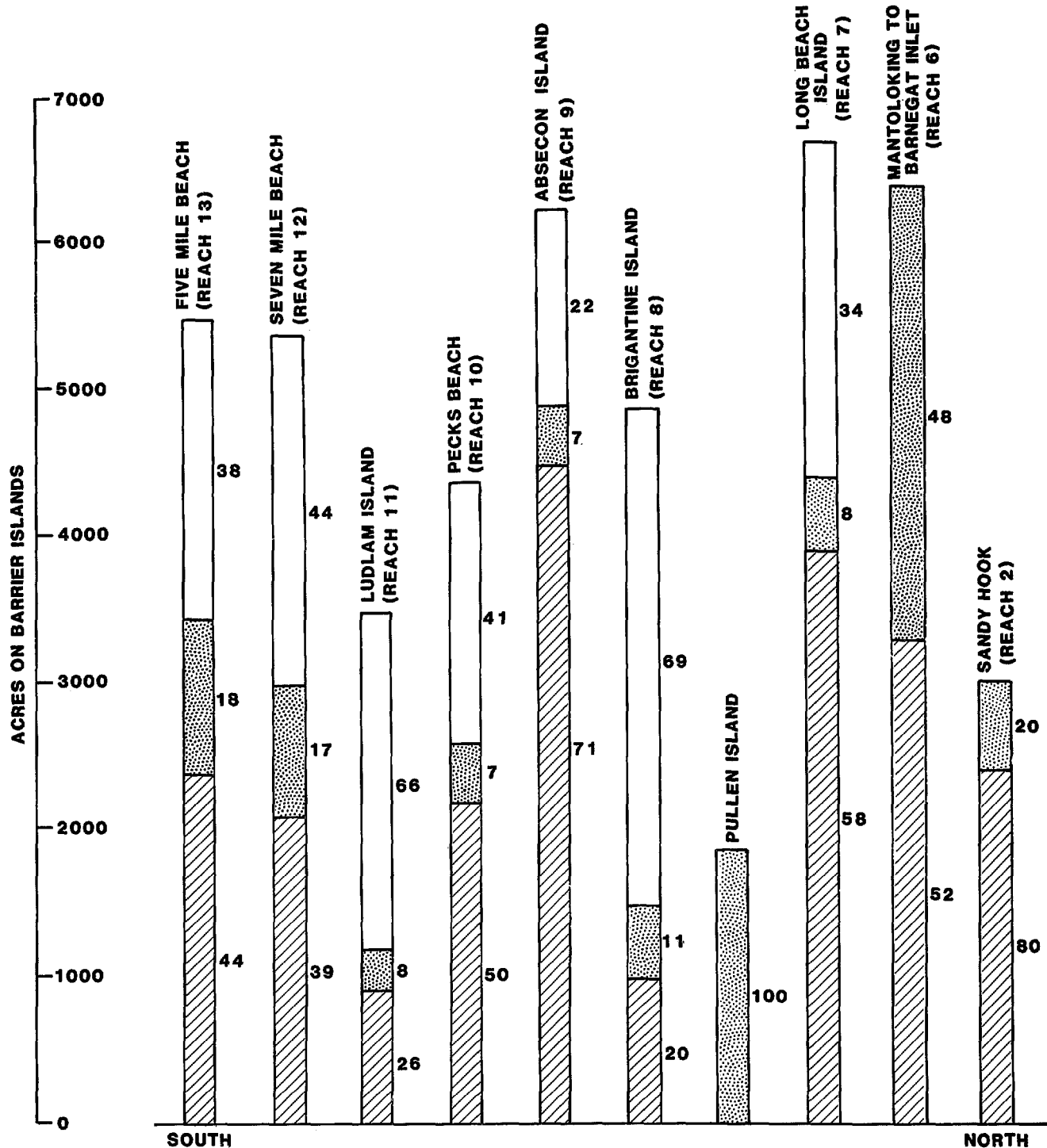
39% PROTECTED

15% UNPROTECTED/UNDEVELOPED

## EXTENT OF DEVELOPMENT ON NEW ENGLAND AND MID-ATLANTIC COAST BARRIER ISLANDS

REFERENCE: DATA FROM HCRS, 1980.

DAMES & MOORE



DEVELOPED  
 PROTECTED (PARKS, PRESERVES, ETC.)  
 UNPROTECTED/UNDEVELOPED

#### STATE REACH AVERAGE

47% DEVELOPED  
 20% PROTECTED  
 33% UNPROTECTED/UNDEVELOPED

71 % OF REACH ACREAGE

## EXTENT OF DEVELOPMENT FOR NEW JERSEY BARRIER ISLAND REACHES

REFERENCE: DATA FROM HCRS, 1980.

DAMES & MOORE

compiled in Sales and Marketing Management Magazine (July 27, 1979), and the estimates of retail sales in New Jersey's counties. In a tourism oriented economy, the seasonal inflow of visitors will result in significantly greater retail sales within the local economy than can be attributed to the local, year round residents. The higher the ratio of total retail sales/MHEBI, the more likely the area is to be a destination of travelers and tourist. The top five ranked counties were coastal counties. The five counties with their respective ratios are: Cape May (0.73), Ocean (0.63), Cumberland (0.61), Atlantic (0.61), and Monmouth (0.60)

The New Jersey shore means different things to different people. In the past it has conveyed the impression of a homogeneous region. Although shore communities have many common characteristics, substantial differences do exist. A brief discussion of socioeconomic characteristics highlighting the commonalities and the differences in shore communities and reaches is provided in Volume 2, Section II.D.

To aid in the evaluation of direct and indirect socioeconomic impacts associated with the implementation of shore protection, the coastal municipalities and shoreline reaches have been classified into one of four categories — urban, rural, residential, or recreational/water dependent. The classification methodology, results, and discussion are provided in Volume 2, Section II.D.5.

## 5. Environmental Setting

This section briefly describes the similarities and differences of the ecological and biological resources along the New Jersey shoreline. The relative importance of these resources is considered in assessing the potential impacts which may result due to the implementation of different shore protection alternatives. A more detailed description of the ecological habitats (beaches, dunes, nearshore zone etc.), and cultural and biological resources (fisheries, shellfisheries etc.) along the New Jersey shoreline is presented in Volume 2, Section II.E.

Basically, two different types of shorelines are of concern: ocean beaches (Reaches 2-14); and bay beaches (Reaches 1, 15, 16, and the backbay areas). Generally, the reaches with common shoreline types are ecologically similar. Therefore, this section will address the key ecological concerns which were used in the impact assessment for each of the shore protection alternatives evaluated.

The sandy ocean beaches are primarily found from Sandy Hook to Cape May Point (Reaches 2 thru 14). They are bordered on the east by the Atlantic Ocean, and occur on both barrier islands and headland reaches. The organisms which inhabit the ocean beach are not directly considered of commercial importance, although many do serve as food sources for important commercial species. The species distribution for the ocean beach habitat is similar from Reach 2 through Reach 14. Therefore, no single sandy beach is considered more significant than another with respect to the invertebrate populations in the upper, middle, and lower tidal zones. Similarly, the populations associated with the artificial rocky zones, which occur along sandy beaches (e.g., groins and jetties), are also similar along the entire ocean coast with respect to faunal distribution. Their ecological significance is discussed in Volume 2, Section II.E.

Rocky structures provide suitable substrate for the attachment of algae and numerous invertebrates as well as for shelter for fish and crabs. Given this attraction for fish, areas with greater numbers of groins and jetties (such as Reaches 2-5) have a higher resident fish population than is normally found along a sandy beach.

Fish species utilizing the subtidal area of a sandy beach are typically migrating species such as striped bass, fluke, and bluefish. Although these three species are caught around groins and jetties, the rocky subtidal is also populated with numbers of black sea bass, tautog, and bergall. Considering the general distribution of important finfish, recreational fishing on a sandy beach is greater in areas with significant numbers of rocky structures, than in areas without such structures. This distribution can be quite variable given the seasonal migrations and other physical oceanographic conditions which can result in large numbers of fish being present off of a particular sandy beach. Such conditions are usually short-lived whereas recreational fishing in the vicinity of rocky structures might be more consistent.

Shellfish beds and finfish are the most significant resources in the nearshore zone off sandy beaches. The surf clam, which is the most important commercial shellfish resource in New Jersey, does occur near the beach in shallow water. Densities of the surf clam have been mapped by Haskins and Merrill (1972). They report that commercial densities of surf clam are found off all reaches with the exception of Reaches 3, 4, and 5. However, the most significant beds are found off Reaches 9, 11, 12, 13, and 14, and in the vicinity of most coastal inlets.

With respect to most finfish resources in the nearshore zone, as discussed above, their distribution is spatially and temporally variable. More resident populations are found around shipwrecks, artificial reefs, and in the area of the Shrewsbury Rocks. Shipwrecks occur off of all reaches and appear to be most numerous around Reaches 2, 3, 5, 8, 9, and 12. The State's two artificial fishing reefs and the Shrewsbury Rocks are located off Reaches 2 and 4.

Landward of the beach area is the dune zone. Much of the dune system along the New Jersey coast has been disturbed by man's activity. Such activity has included the destruction of or flattening of the primary dune line due to construction activities. At the present time, few undisturbed dune areas exist in developed areas.

Also of importance in the beach/dune area are colonial waterbird nesting areas. The occurrence of colonial waterbirds along the New Jersey coast has been reported by Gali (1978). Beach nesting locations for colonial waterbirds have been reported in Reaches 2, 11, 12, 13, and 14.

Like the ocean beaches, the bay beaches which occur along the Raritan Bay, Delaware Bay, and Delaware River (Reaches 1, 15, 16, respectively), and in all coastal back bay areas, are made up of different ecological habitats (beach, wetland, etc.) These habitats do not exhibit significant uniqueness within the geographic area affected by the Master Plan. For example, wetland marshes along Raritan Bay resemble other wetland marshes which occur along Delaware Bay and backbay wetlands along Great Bay or Barnegat Bay. Bay beach habitat types are discussed in more detail in Volume 2, Section II.E.

## CHAPTER II

### THE SHORE PROTECTION MASTER PLAN FOR NEW JERSEY

#### A. INTRODUCTION

This chapter presents a brief discussion of the selection of alternatives, the major findings, and the major component programs of the Shore Protection Master Plan. The summary of the major components of the plan is followed by specific recommendations including a reach-by-reach synopsis of the details of the preferred engineering plans.

##### 1. Choices

There is a wide range of techniques that have been implemented at various levels of government, and by individual, private shorefront property owners to adjust to coastal erosion processes. These alternative techniques are shaped by the often conflicting objectives or priorities that exist among the various potential initiators of shore protection alternatives.

Historically, shore protection alternatives have been directed toward protecting the sizable public and private investment in development that has occurred along New Jersey's ocean shore. This development has resulted in the evolution of an economically important recreational and tourism industry that yields significant public and private economic and social benefits.

More recently, emerging Federal and State shore protection policies have questioned the wisdom of unregulated development of the oceanshore — and in particular — the barrier islands. It has been increasingly recognized that considerable subsidized flood insurance and shore protection costs are associated with intensive development of hazardous shorefront areas, and on barrier islands in particular. In addition, it has become increasingly clear that there are strong societal and environmental benefits to be gained by maintaining or restoring (to the extent practicable) the natural dynamic processes controlling shore erosion and barrier island migration.

These two conflicting philosophies have engendered the development of two basic approaches to shore protection. On the one hand are the engineering techniques and concepts (structural and nonstructural), designed primarily to reduce the direct, adverse effects of erosion on shorefront property by controlling or mitigating the natural forces that cause the erosion. On the other hand are the non-engineering approaches which seek to either avoid future erosion losses through land management programs, or to lessen or eliminate the direct social and economic costs and hardships incurred by shorefront property owners where erosion is occurring.

Sorensen and Mitchell (1975) have classified the alternative adjustments to coastal erosion into four major categories:

- o Control and Protection Works (Engineering Alternatives)
- o Land Use Management
- o Warning Systems
- o Public Relief, Rehabilitation, and Insurance Means

These four major categories are introduced and explained briefly below. Various alternative techniques and concepts under each of the major categories above are presented along with a discussion of the compatibility and interaction of alternatives in Volume 2, Chapter IV.

a. Control and Protection Works (Engineering Alternatives)

Engineering alternatives consist of structural and nonstructural measures of erosion control. Structural solutions used as a last resort to form a protective barrier against the encroaching sea typically include massive shore-parallel works such as seawalls, revetments, and bulkheads. Other structural approaches which are designed to slow the erosion by modifying the wave energy or littoral drift processes consist of breakwater, jetties, groins, artificial seaweed, and similar devices. Nonstructural works include beach nourishment projects, and dune and bluff stabilization using vegetative plantings and sand fencing.

The primary thrust of the engineering alternatives is one of maintaining a static shoreline to protect or enhance adjacent development. All of the structural approaches tend to be very expensive, and some tend to increase the rate of loss of the beach resource. Groins and jetties, while they slow the erosion at a particular location, may have the effect of increasing erosion on downdrift shoreline areas. Often as a result of this situation, continued control further along the coast is needed. Bulkheads, seawalls, and revetments tend to increase the reflective energy and turbulence along a shore and inhibit the natural beach recovery response to storms, resulting in accelerated losses of the fronting beach.

Although nonstructural measures such as dune stabilization and beach nourishment have been recognized for some time, it was not until the late 1950s, after extensive research, that they were considered seriously. Recently, beach nourishment has become the most preferred Federal erosion control technique. However, the costs of nourishment are also very high, extensive losses are often experienced following nourishment projects, and continued maintenance or renourishment is required.

b. Land Management

The efforts to utilize land management programs as adjustments to the coastal erosion hazard must be viewed against a background of sustained population and investment growth in shore areas and of intense competition among resource users. Land management programs attempt to minimize potential losses by controlling development and investments in the erosion hazard zones. The emphasis here is to reduce the losses over the long term by recognizing the dynamics of the coastal system, adjusting man's activity to be compatible with it and not attempting to modify the natural system to maintain a static shoreline as in engineering works. Tools of land management include acquiring existing open space land areas and enacting and enforcing building codes, ordinances, or other land use regulations. Construction setback lines and regulations protecting the dune/beach system are the most commonly employed land management tools.

c. Warning Systems

Warning systems can be utilized to alert the occupants of potentially affected areas to the onset of erosion or flood hazards. Coastal erosion warnings are sometimes issued from the National Weather Service forecasting centers in conjunction with storm surge and high water warnings. Normally, there is little danger to

human life due to erosion hazards. The current emphasis of the warning system is related to the flooding hazard associated with major coastal storms. Without other contingency programs in place and ready to operate, there is little that can be done on short notice to prevent extensive erosional loss of beaches, dunes, and structures.

Warning systems can also encompass public education and public awareness programs. Under this approach, the public (i.e., shorefront property owners, potential investors, tourists, etc.) would be made more aware of the dangers associated with development in coastal erosion hazard and storm hazard areas. This could include estimates of the likelihood of future property loss from continuing erosion or major storms. It must be recognized that warning systems do not directly avoid property losses or decrease human suffering. However, they can be useful adjuncts in making people more amenable to other approaches.

#### d. Relief, Rehabilitation, and Insurance Measures

These programs provide a means of compensating victims of erosion by spreading the social costs. Most methods of spreading disaster losses are unavailable to persons affected by coastal erosion. Relief and rehabilitation aid can be allocated to an area after Presidential declaration of a major disaster. This provides for a range of aid including low interest loans (Office of Emergency Preparedness, 1972). Except when accompanied by other catastrophic storm events, most episodes of serious erosion have not resulted in Presidential declaration of a major disaster. Under the National Flood Insurance Program, insurance is available for erosion damages only for accelerated cases when waves or currents exceed anticipated cyclical levels.

Additional programs can also utilize incentives to encourage shorefront property owners to relocate in other areas. Public resources (e.g., low interest loans, grants, relocation assistance, etc.) could be made available to persons in the hopes of avoiding higher, future costs (disaster assistance expenses). In addition, the amount of insurance settlements could be predicated on rebuilding destroyed structures out of hazardous areas.

## 2. Selection of Alternatives for New Jersey

In the selection of the shore protection alternatives for New Jersey, all of the available shore protection techniques and concepts were considered. With consideration of Master Plan objectives, State and Federal shore protection policies, operative coastal processes, shoreline conditions, and the density of development along the shore, a comparative evaluation of selected practical engineering and land management alternatives was performed. The alternative evaluation, which is provided in Volume 2, Chapter V, addresses the following questions: What are the pros and cons of each approach? What is the actual cost of continuing to protect development adjacent to eroding shores? What are the benefits and who are the beneficiaries? What are the impacts on the socioeconomic system and on the natural ecosystem and resources? How might combinations of alternatives present opportunities for increased shore protection benefits?

Thus, the stage was set for decisions regarding which approach, or combination of approaches, should be the direction for the State in the years to come. Considering the evaluations and recommendations provided in the Draft Shore Protection Master Plan (Dames & Moore, September 1980), and written and public hearing comments on that document, the DEP adopts the findings and programs summarized in the following sections.

### 3. Findings

- o Coastal resources are essential to the welfare, commerce, and prosperity of the people of the State.
- o The coastal areas of the State, including beaches, dunes, and coastal bluffs adjacent shorefront areas, are subject to natural disasters of inundation (flooding) and to dynamic changes resulting in erosion and accretion.
- o The beaches, dunes, and adjacent shorefront areas (uplands and coastal bluffs) provide valuable recreational, scenic, and protective functions, and are important habitats for wildlife and vegetation.
- o Beaches, dunes, and coastal bluffs operate in equilibrium with and moderate the effects of flooding and shoreline dynamics by migrating in response to coastal processes and sea level rise.
- o Development within these coastal hazard areas has resulted in destruction of valuable dune areas and increases in losses associated with the natural disasters of flooding and erosion.
- o Attempts to prevent hazard losses and maintain a static shoreline by construction of costly engineering projects, especially shore-parallel structures such as bulkheads and seawalls, have resulted in losses and damage to the natural beach systems and related resources.
- o Nonstructural engineering projects, such as beach nourishment, can provide some level of protection against erosion and storm-related effects.
- o Beaches can be renourished to return recreational and protective functions and benefits, but only at high costs.
- o There is no guarantee that major storms capable of destroying shore protection projects and development will not occur; correspondingly, the anticipated benefits which would justify such projects may not occur.
- o The static shoreline concept related to coastal development requires that beach nourishment and structural maintenance be continued indefinitely if the beach resources and development in the coastal hazard zone are to be maintained.
- o Land regulations of coastal hazard and sensitive areas can provide a long-term mechanism for effective mitigation of erosion losses; such regulation should be in place now, prior to the next major storm, to effectively guide the pattern of rebuilding.
- o Land regulation will not help to reduce short-term losses to existing development in the coastal hazard areas.
- o Programs to encourage relocation out of coastal hazard areas after destructive storms are needed.
- o Due to the prohibitive costs and the potential for significant political and social disruption, acquisition of entire barrier islands or large tracts of

coastal high hazard areas is not feasible as a means of coastal hazard mitigation.

- o Limited pre-storm acquisition of undeveloped access areas, and selected post-storm acquisition of portions of the barrier islands, especially areas on the tips of islands adjacent to inlets, would be an appropriate supplement to land regulation. Acquisition would also provide increased levels of public access and natural recreational opportunities for beach use.

#### 4. Summary of Plan Components

To accomplish the objectives outlined in Chapter I, this Shore Protection Master Plan has the following objectives:

- o Implementation of priority reach-level and selected local engineering programs;
- o Land use regulation in coastal hazard and resource areas (beaches and dunes);
- o Selective post-storm acquisition of portions of barrier islands;
- o Parallel Federal programs which would be supportive of State coastal management policies and functional in providing incentives and assistance for relocation especially after destructive storms.

Each of the adopted plan components of the Shore Protection Master Plan is described below in more detail. The preferred engineering programs are shown schematically on Figure II.A-1.

To alleviate the anticipated short-term losses associated with storms and erosion processes, priority nonstructural reach-level and selected non-reach engineering projects would be implemented. To maximize the potential for Federal cost sharing assistance and to ensure expenditure of State and local monies in an equitable manner, only those projects which are beneficial and affordable should be implemented.

Shorefront regulations is primarily a local responsibility although the DEP does operate three regulatory programs which currently form the backbone of the State's existing Coastal Management Program. These are the coastal wetlands, coastal area facility, and waterfront development (riparian) permit programs. In accordance with its stated coastal management policies, the New Jersey Department of Environmental Protection, Division of Coastal Resources (DEP/DCR) is moving forward to develop land management tools for addressing the problem of shoreline erosion. To this end the DEP/DCR intends to work closely with coastal municipalities to develop workable regulatory legislation. Thus, a long-term component for mitigation of the shoreline erosion problem will be the use of coastal regulation to control development in the hazard and natural resource (beach and dune) areas. Under a plan inclusive of coastal regulation, as development in the hazard areas decreases over time, continued reliance on engineering projects will diminish and the cost associated with their construction and maintenance will decrease. A decrease in development in the coastal hazard strip along the shore, together with selected public acquisitions of the shorefront, will mitigate losses associated with shoreline erosion and will provide for increased levels of access to the beaches. While such regulation would provide the

DAMES & MOORE

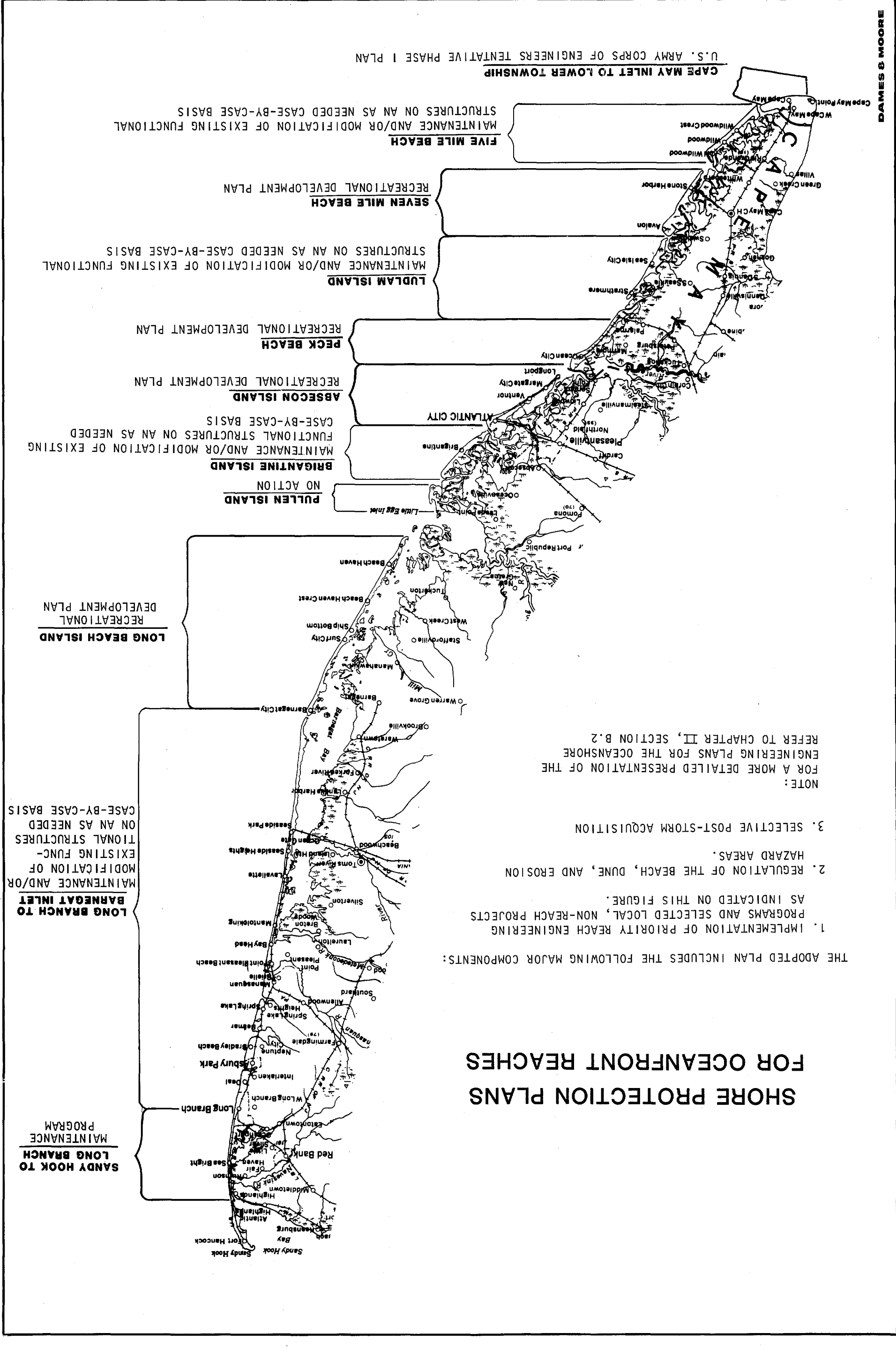
CAPE MAY INLET TO LOWER TOWNSHIP  
U.S. ARMY CORPS OF ENGINEERS TENTATIVE PHASE I PLAN

# SHORE PROTECTION PLANS FOR OCEANFRONT REACHES

THE ADOPTED PLAN INCLUDES THE FOLLOWING MAJOR COMPONENTS:

- 1. IMPLEMENTATION OF PRIORITY REACH ENGINEERING PROGRAMS AND SELECTED LOCAL, NON-REACH PROJECTS AS INDICATED ON THIS FIGURE.
- 2. REGULATION OF THE BEACH, DUNE, AND EROSION HAZARD AREAS.
- 3. SELECTIVE POST-STORM ACQUISITION

NOTE:  
FOR A MORE DETAILED PRESENTATION OF THE  
ENGINEERING PLANS FOR THE OCEANSHORE  
REFER TO CHAPTER II, SECTION B.2



best immediate solution for sparsely developed coastal areas, given the heavily developed nature of the New Jersey shore, the implementation of shore protection engineering projects will continue to be an important component of the New Jersey Shore Protection Master Plan Program.

For maximum effectiveness of the Master Plan regulatory components discussed above, parallel and supportive Federal actions would also be appropriate. At a minimum, the State intends to support changes in existing Federal flood insurance and disaster assistance programs, and evolving barrier island legislation, to provide upgraded coastal construction standards, relocation incentives, and assistance for occupants of coastal high-hazard areas. However, it is unlikely that Federal relocation programs would be in place for some time, and even if in place, would probably not be used extensively, except in post-storm situations to assist property owners to rebuild in different, including further inland, locations.

A schematic representation of components of the plan and their interaction over a period of time is presented in Figure II.A-2. This schematic time interval is punctuated by a number of storms. As time proceeds, the losses suffered and the related threats to public health and welfare decrease. This reduction will be directly related to the extent of development in the hazard areas, which is controlled by:

- o The coastal regulation which would control new development and redevelopment on shorefront property in high hazard areas;
- o Acquisition of lands for public open space — natural areas, especially post-storm acquisition on portions of barrier islands; and
- o Voluntary relocations of businesses and residents to safer areas after destructive storms.

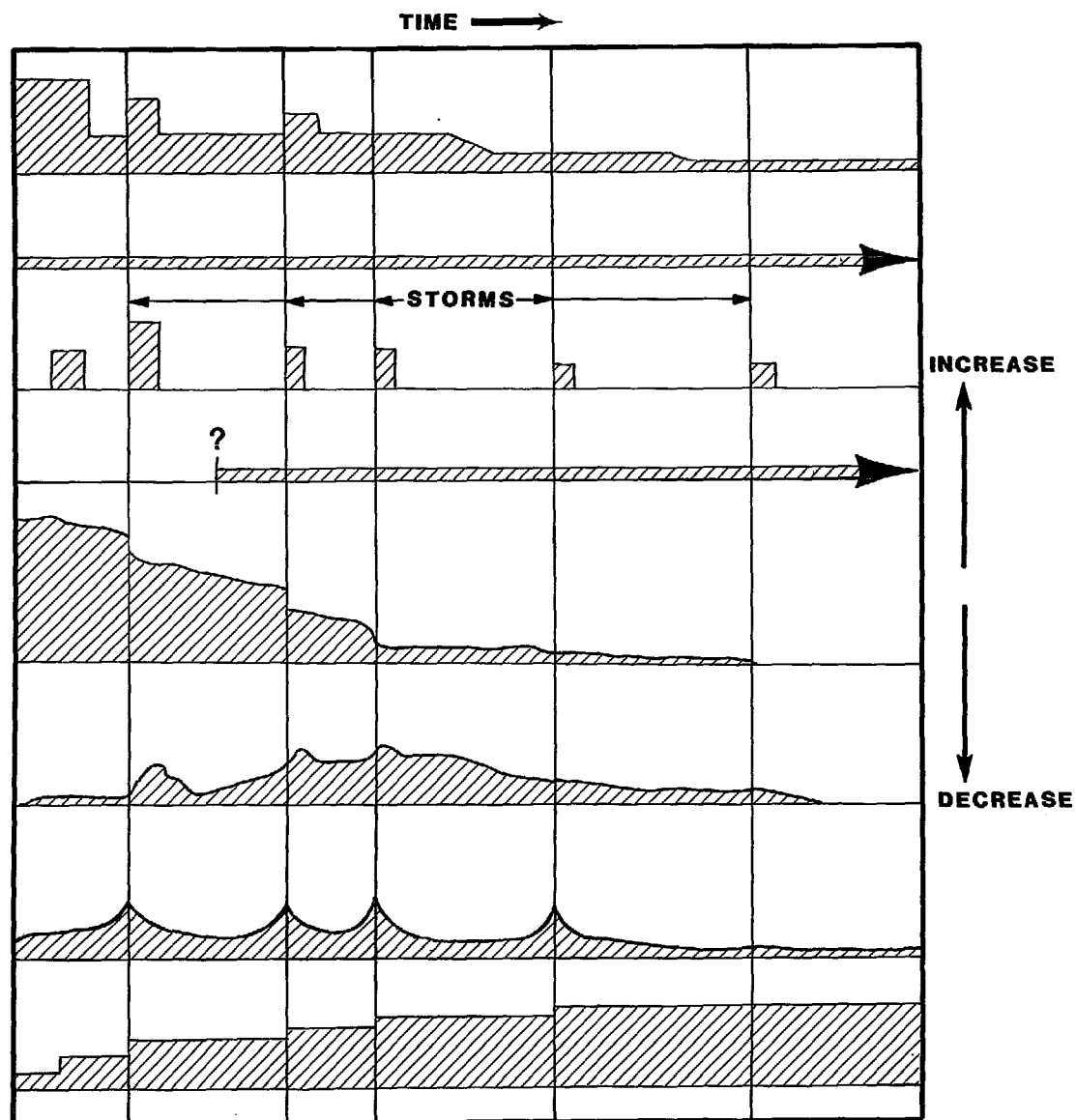
#### B. COASTAL ENGINEERING PROGRAMS

There are a wide range of engineering concepts and techniques that have been implemented at various levels of government, and by individual private shorefront property owners to reduce and direct natural forces which adversely affect shorefront property. Available engineering erosion control concepts and techniques are presented and discussed in detail in Volume 2, Section IV.B.

Historically, structural measures (including breakwaters, seawalls, groins, bulkheads, and revetments) and nonstructural methods (such as beach nourishment and dune stabilization) have been implemented to maintain a static shoreline to protect and enhance the sizable public and private investment in development that has occurred along New Jersey's ocean shore. This development has resulted in the evolution of an economically important recreational and tourism industry that yields significant public and private economic and social benefits.

However, the engineering alternatives have become increasingly more expensive and some of the structural methods have accelerated the rate of the loss of beach resources and adjacent shoreline areas, especially where they have been implemented on a piecemeal basis. In order to alleviate this problem the alternative reach engineering designs are proposed.

The principles and assumptions for design of the alternative engineering alternatives for New Jersey are set forth in the following sections.

**ACTIONS****ENGINEERING SHORE  
PROTECTION PROJECTS****LAND USE REGULATION  
FOR COASTAL EROSION  
HAZARD AREAS****ACQUISITION****RELOCATION INCENTIVES****REACTIONS****DEVELOPMENT IN  
COASTAL HAZARD AREAS****RELOCATIONS****HAZARD LOSSES****PUBLIC ACCESS TO  
BEACHES**

**SCHEMATIC REPRESENTATION  
INTERRELATIONSHIPS OF PLAN ELEMENTS WITH TIME**

## 1. Engineering Principles and Assumptions

### a. Rationale and Assumptions For Design

As discussed in Section I.B above, this study addresses the shore areas which are exposed to significant erosional forces and have had a history of erosion problems. In particular these areas include the Raritan Bay shore from Perth Amboy to Sandy Hook; the Atlantic Ocean shore from Sandy Hook to Cape May Point; the Delaware Bay shore from Cape May Point to Stow Creek; and the Delaware River from Stow Creek to Crosswicks Creek. Detailed consideration of engineering alternatives is provided for the ocean shores which, by comparison to river and backbay shores, have the most significant erosion problems. Where appropriate, development of the engineering plans is based on a regional (reach) approach, rather than the as needed, piecemeal solutions of the past.

The Corps of Engineers, in cooperation with the State, has developed a series of plans for comprehensive shore protection of the ocean beaches and inlets. These plans, which are discussed in Volume 2, Section VI.C., have received congressional authorization, but most are in the inactive category because of the inability of State and local government units to commit to the initial cost-sharing and maintenance responsibilities. In New Jersey, the general practice of the Corps of Engineers with regard to inlet stabilization has been to propose costly master jetties for navigation purposes; however, a few projects which do not involve major inlet stabilization costs have been completed. Three Federal shore protection projects have been completed on the New Jersey Coast — on Long Beach Island, at Atlantic City, and in the Keansburg area of the Raritan Bay shore.

The reach engineering conceptual designs that are developed and evaluated in the New Jersey Shore Protection Master Plan are alternatives to authorized Corps of Engineers shore protection plans for New Jersey which have been developed over the last 20 years. Considerations of inlet stabilization (including master jetty construction for navigational improvements and sand bypassing to prevent adverse effects on downdrift beaches), which is a component of the Corps of Engineers multipurpose projects, is not included in the Master Plan due to its high cost, predominance of navigation benefits, and the potential for adverse effects on adjacent shore areas.

For the reach engineering designs presented in this document, a uniform set of design criteria and assumptions has been applied. The design methodology for engineering protection of the New Jersey shoreline is based on four fundamental assumptions:

- o The overall coastal processes of the State should not be altered.
- o The "reach" concept should be employed in the application of engineering plans, where appropriate.
- o Although the Master Plan engineering alternatives include consideration of storm erosion protection, flood control or protection measures are not addressed explicitly. The controlling measures and long-term effects of flooding and erosion are substantially different.
- o Plans should be in accordance with the State's policies for shore protection as set forth in the New Jersey Coastal Management Program (NJDEP/NOAA, August 1980).

Thus, the erosion control solutions are created such that the overall coastal processes of the State are not significantly altered, since it is assumed that such an alteration would be detrimental.

The New Jersey Coastal Management Program emphasizes nonstructural solutions for shoreline protection. Structural solutions are only acceptable when nonstructural alternatives are incompatible with protection demands. Another important aspect of the State program requires that public and private resort-recreation developments adjacent to the shoreline provide for reasonable public access. Access takes the forms of visual and direct or indirect physical access; indirect physical access includes provision of parking, transportation, and support facilities. All shorelines protected with State or Federal funds must be accessible to all shorefront visitors on equal terms.

Although stated shore protection policies are primarily in favor of non-structural engineering techniques, such as beach nourishment, the construction of new shore protection structures, such as jetties, groins, seawalls, and bulkheads, is conditionally acceptable if they meet the following specifications:

- o The structure is essential to protect water-dependent facilities or heavily used public recreation beach areas from tidal waters or erosion, or to protect existing structures and infrastructure in developed shorefront areas from erosion.
- o The structure is designed to eliminate or mitigate adverse impacts on the local shoreline sand supply.
- o The structure will not create adverse shoreline sand movement conditions downdrift, including erosion or shoaling.
- o The structure will cause minimum adverse impact to living marine resources.
- o The structure is consistent with the State Shore Protection Master Plan conceptual engineering plans.
- o If the proposed project requires filling of a water area it must also be consistent with the General Water Area Policy for filling as specified in The New Jersey Coastal Management Program (NJDEP/NOAA, August 1980).

The recommendation of this Master Plan is that existing and proposed shore protection policies be followed except for the following suggested modifications:

- o It is recommended that shore-parallel structures — such as bulkheads, seawalls, and revetments — in areas characterized by sandy beaches, especially on ocean shores, be prohibited except for those recommended in the Shore Protection Master Plan as infilling to maintain the integrity of adjacent structures. These structures impede the natural migration and storm responses of sandy shores and result in significant increased losses of natural beach areas. The previous conditional policies for structural engineering techniques should apply to the remaining non-shore-parallel structures such as groins and jetties.

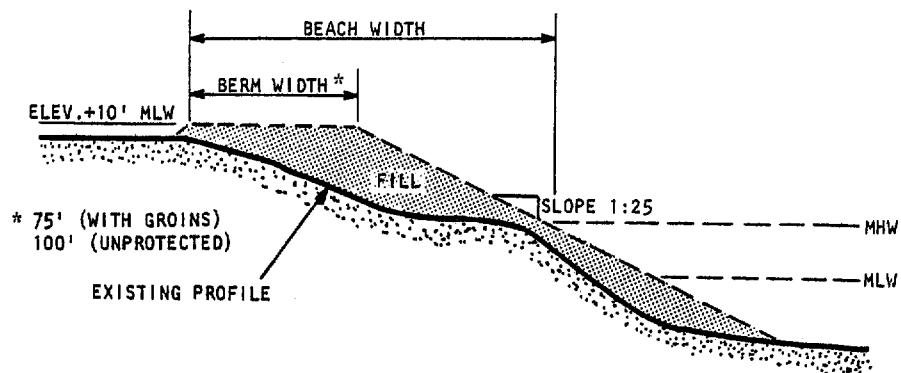
- o Costly reach-level engineering programs should be implemented only if they are cost beneficial (benefit-to-cost ratio greater than one). The priority projects on the ocean reach level identified in this plan meet this criteria. However, other projects which will develop on a case-by-case basis — in the bay and inlet areas, for example — should also demonstrate a positive benefit-to-cost relationship prior to priority funding.
- o Long-term, costly reach engineering projects, such as extensive beach fill and groin construction, should not be implemented as emergency projects.

Specific criteria have been established for this Master Plan to provide the necessary parameters for engineering planning and analysis. These criteria are generally consistent with the planning values used by the Corps of Engineers in its feasibility level studies. In later detailed studies, the design specifications would be subject to change depending on actual physical conditions (e.g., wave climate and beach width) at the site.

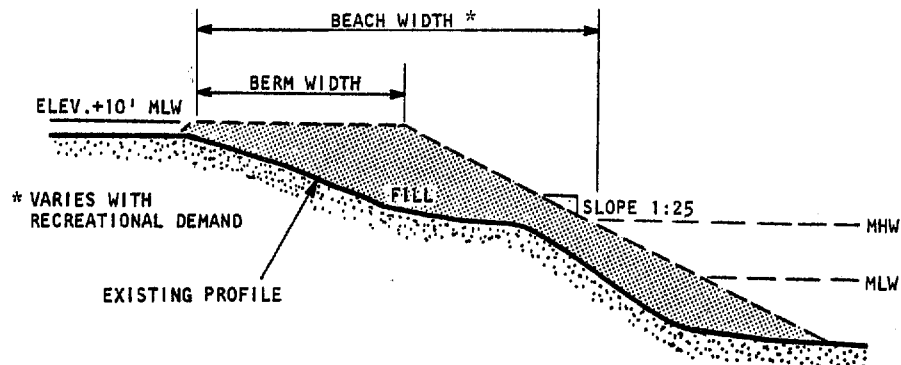
The following design criteria and assumptions were established with regard to the selected alternative engineering plans:

- o A 50-year program life is assumed for economic evaluations.
- o For storm erosion protection designs, beaches will have a 100-foot berm width on shoreline without groins and a 75-foot berm width on shoreline with functional groins (see Figure II.B-1).
- o Recreational beaches shall be of sufficient surface area to provide a maximum of 100 square feet per person for recreational use. This value, as recommended in the State Comprehensive Outdoor Recreation Plan (SCORP), (NJDEP, 1977), is higher than the 75-square-feet-per-person criterion used by the Corps of Engineers in its design procedures.
- o An average beach user turnover rate of 2.0 is assumed in the daily beach capacity estimates. This value is consistent with the Corps' estimating procedure.
- o Beach berm and dry beach slope areas are used in the computation of recreational capacity.
- o Recreational beach shall only be added to an existing beach where there is public access.
- o A nourished storm erosion protection beach shall have a slope paralleling the original beach profile and a berm elevation of 10 feet above Mean Low Water (MLW) (see Figure II.B-1).
- o Where recreational development designs require beach expansions to accommodate demand, final design berm elevations are planned at +10-foot MLW level to maintain a dry berm during normal high tide conditions.
- o Dune maintenance and development are provided through a program of sand fence installation and dune grass planting. No newly constructed dune fields are planned for inclusion in beach fill design cross-sections.

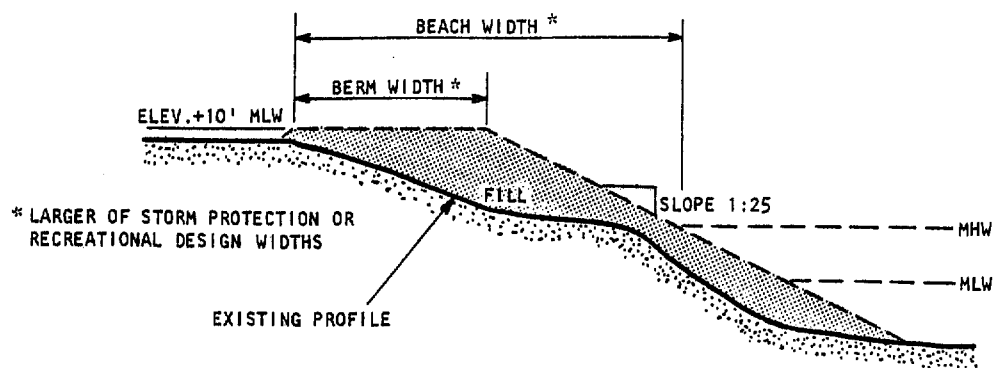
# TYPICAL DESIGN BEACH PROFILES



## STORM EROSION PROTECTION ALTERNATIVE



## RECREATIONAL DEVELOPMENT ALTERNATIVE



## COMBINATION ALTERNATIVE

DAMES & MOORE

- o Normal structural maintenance costs are estimated by using a uniform series of annual payments which is equivalent to the cost of replacing a structure at the end of its 50-year economic life. This assumes that the structure is in excellent condition to start with, if not, initial repair (initial maintenance) costs are added to the project.
- o Estimates of initial structural maintenance (repair) costs for each reach are taken from a State study entitled Shore Protection Structures, Public Access and Evaluation (NJDEP, Office of Shore Protection, January 1977). Cost estimates provided in that study have been upgraded to 1980 dollars for inclusion in the Master Plan.

In addition to the specific criteria identified above, several assumptions were necessary to substitute for unknown or inadequate data. These assumptions include oceanographic, demographic, economic, and environmental data as summarized below:

- o Offshore sand sources identified by the U.S. Army Coastal Engineering Research Center have grain size distributions which are compatible with the native beach sands.
- o A nourishment overfill factor of 1.3, typical of suitable beach fill materials, is used — based on the assumption that adequate quantities of such borrow material are available.
- o Coastal processes in each reach will not be significantly altered naturally or by man except as recommended in the Master Plan.
- o Well-designed groin fields reduce erosion rates by approximately 25 percent. The effectiveness of existing groin fields may vary from this estimate due to various local factors.
- o A rate of return of 9 percent is used in the economic analysis.
- o Recreational beach demand data are assumed to be valid as extrapolated to the year 2030, based on SCORP data (NJDEP, 1977) and Corps of Engineers Planning documents, and carrying-capacity estimates for major access routes to reaches.
- o Recreational demands can be adequately met by providing a beach capacity based on a mean between the projected average and peak daily beach use estimates.
- o Recreational beach demand can be satisfied by incremental increases in capacity at approximately 10-year intervals, resulting in a step function increase in capacity from the existing levels to those projected for the future.
- o Dredging contracts can be let with sufficient volumes to attract dredging contractors in a competitive situation. One million cubic yards is assumed to represent a minimum size for an attractive project. Smaller projects in adjacent reaches may be combined to meet this guideline. Minor adjustments in the schedules for renourishment and berm expansion can also be made so that these two beachfill steps are concurrent.

- o Adequate dredging equipment will be available to economically obtain sand from offshore sources.

b. Alternative Reach Engineering Plans

Five alternative reach engineering plans have been developed and evaluated for application to the New Jersey ocean shoreline:

- o Storm Erosion Protection
- o Recreational Development
- o Combination Storm Erosion Protection and Recreational Development
- o Limited Shoreline Restoration
- o Maintenance Program.

These alternatives represent a range of engineering objectives for erosion control — from a comprehensive program which maximizes erosion protection and recreational benefits to a minimum program of maintenance of existing structures. In each of the engineering concepts, specific actions are recommended so as to achieve the design objective in a cost-effective and efficient manner. Economic evaluations were performed in the selection of competing technical options. An expanded discussion of assumptions and concepts for each of the alternatives discussed below is provided in Volume 2, Section VI.A.2.

(1) Storm Erosion Protection. This alternative concept has as its objective the protection of property and community infrastructure from probable erosion damage following a major storm. Flood protection design is not provided by this alternative. Beach berms are raised to elevations which provide a dry beach under normal high tide and wave runup conditions. Dunes are not added to provide flooding and overwash protection, but maintenance and continued development of existing dunes are provided through a program of beach grass planting and sand fence installation.

For the purposes of this study, the design storm has been selected from the historical record and has an approximate recurrence interval of 50 years. Stabilization is accomplished through nonstructural techniques (beach fill, dune maintenance, etc.) to the maximum practical extent in accordance with New Jersey Coastal Management Program policies. Structural shore protection plans are only conditionally acceptable under this program; they are appropriate and essential along certain heavily urbanized portions of the New Jersey coast. Structural measures including seawalls, bulkheads, breakwaters, and groins are specified only when nonstructural approaches are infeasible or impractical.

Both structural and nonstructural techniques are applied so as to provide a buffer of sufficient resistance to limit erosion losses of public/private property or infrastructure during a design storm. Generally, exposed beaches with berm widths of 100 feet and groin-protected beaches with berm widths of 75 feet represent suitable means of erosion protection under such conditions. The limited use of seawalls and bulkheads (as infilling) satisfies this protection requirement in areas that are heavily developed.

The storm erosion protection alternative also provides for the maintenance of the erosion buffer. Beach nourishment at periodic intervals is provided to replace erosion losses so that the full protective benefit of the design berm is preserved during the planning period; additionally, the use of beach fill also provides recreational beach benefits. Maintenance of existing functional shore protection structures and modifica-

tion of those structures that are functionally deficient are also included as considerations in this alternative.

(2) Recreational Development. This alternative concept has as its objective the satisfaction of projected recreational demand. The primary means of achieving this goal is through use of beach fill, with a minimum amount of structural stabilization. This approach allows the use of a phased recreational development plan, wherein beach widths are periodically expanded to meet recreational demand. Opportunities are thus provided during the 50-year planning period to adjust the planned beach expansion to meet actual recreational demand. Maintenance of beach widths, through periodic nourishment and maintenance of functional structures, is also provided under this alternative.

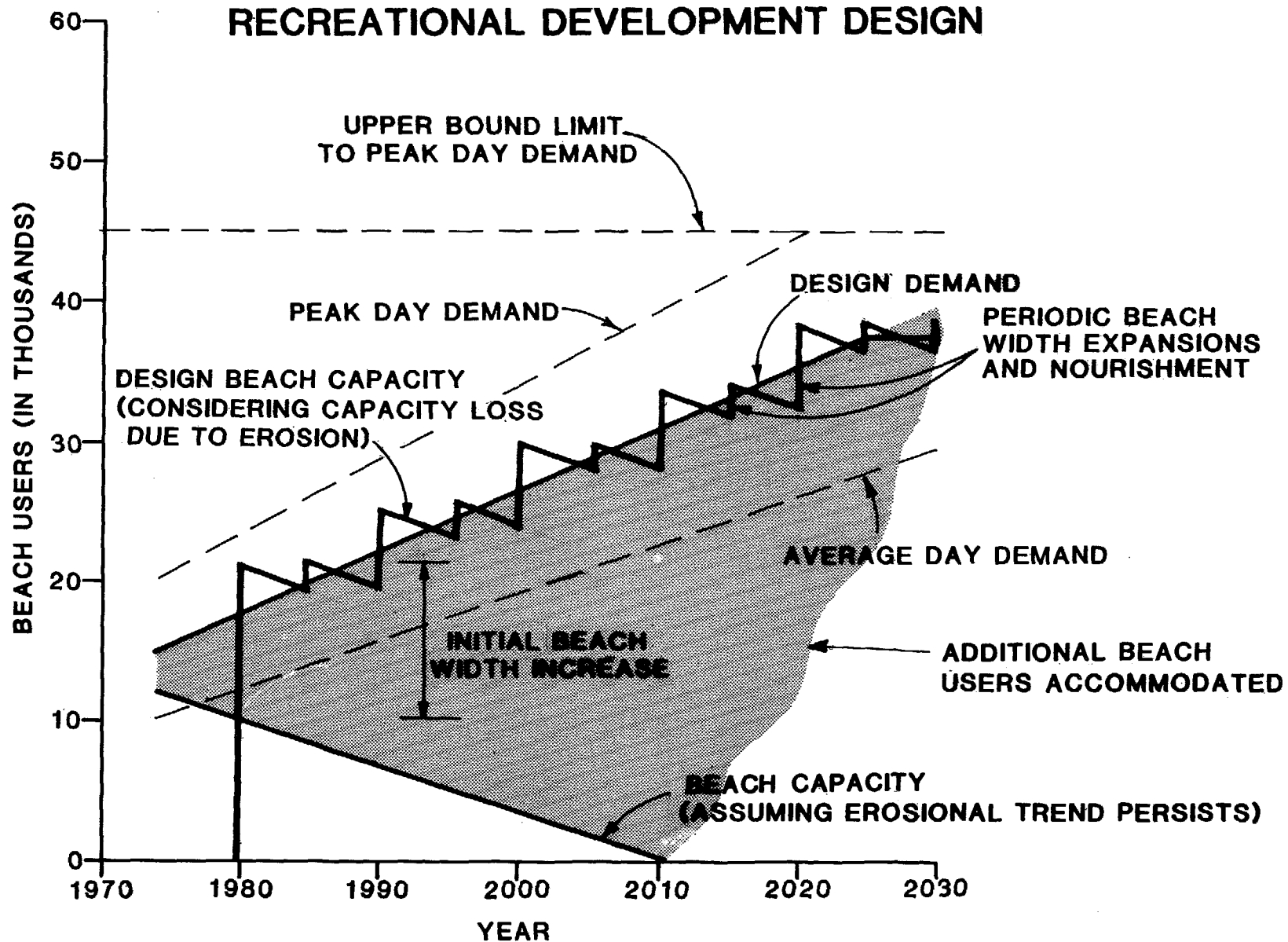
Specific locations within reaches for the development of recreational beach areas are chosen with appropriate consideration of convenient public access. Areas with public ownership of beach area and riparian lands and with convenient access to the beach and parking and support facilities are given preference.

Figure II.B-2 represents a schematic of design beach capacity for a typical recreational reach plan. Average and peak day demands show increases over time, while the existing beach capacity decreases through loss of sand by erosion. The plan provides for periodic beach width expansion over time. This avoids present day expenditures of funds for beach facilities which may not be fully used for another 30 to 40 years. In the example, an initial beach fill increases the beach area to generally satisfy the design beach demand during the first 10-year period. This beach width is then generally maintained at the same level through periodic nourishment. If required, further increases in beach width would occur at approximately 10-year intervals. The spacing of expansions at such intervals provides sufficient time to monitor the performance of the beach fill and the growth of recreational demand. Opportunities are thus provided to readjust beach expansion plans throughout the planning period. Nourishment schedules and volumes can also be adjusted so that nourishment and expansion operations can be conducted simultaneously. This generally provides a fill volume of adequate size to attract bidding interest.

(3) Combination Storm Erosion Protection and Recreational Development. This alternative has the objective of providing the full benefits of both storm erosion protection and recreational development, as described above. The design which results in the wider beach at a particular location controls under the combination alternative. The design can also change through the planning period. For example, a storm erosion protection plan can be the controlling design during the initial years of a project; as recreation demand grows, the beach may reach a point where the storm beach provides insufficient recreational capacity. Then the design would shift to a recreational design and periodic beach expansions would be provided.

(4) Limited Restoration. This alternative is provided to create a level of storm erosion protection or recreation beyond that obtainable from a minimum maintenance program, but less than the full benefits provided by the other alternatives discussed above. The emphasis of the limited restoration alternative is on nonstructural solutions.

## ENGINEERING ALTERNATIVE RECREATIONAL DEVELOPMENT DESIGN



In keeping with the reach concept, the objective of the limited restoration program is to stabilize the critically eroding areas of a reach by bringing the rate of erosion to the same level as other areas of the reach. This is primarily accomplished through restoration of the beach width along with periodic maintenance of the beach. Special consideration is given to the protection of public lands and infrastructure.

(5) Maintenance Program. This alternative represents a program of structural repair and maintenance. The primary objectives are to prevent existing shore protection structures from losing their functional and structural integrity and to provide nourishment material to compensate for that which is eroded during severe storms. In other words, beach renourishment is applied only as a reactionary effort rather than as preventive maintenance. The structural maintenance is performed on a preventive basis. The cost estimates for this program include the maintenance costs for structures only. No costs are included for post-storm restoration of the beach berm due to the unpredictable magnitude and frequency of storm damage.

c. Alternative Reach Engineering Plans Evaluated for New Jersey

Summary descriptions of the engineering alternatives for all reaches are provided in Table II.B-1. Included are the major components of each alternative, such as beach fill, groin construction, and dune stabilization. A full discussion and schematic representation of reach alternatives is provided in Volume 2, Chapter VI.

The alternative reach engineering plans presented here and in Volume 2, Chapter VI, and the reach specific priority engineering projects recommended below, comprise the comprehensive plan (Phase I) of the State's Shore Protection Program. Overall the Program includes four phases:

- Phase I     — Comprehensive State-wide Plan
- Phase II    — Individual Reach Design
- Phase III   — Local Government Coordination
- Phase IV    — Reach Construction

A summary of the estimated costs of the alternatives for the oceanfront reaches (Reaches 2 through 14) is provided in Table II.B-2. Detailed cost estimates are developed in Volume 2, Chapter VI. Specific reach-wide costs have not been prepared for Raritan Bay, Delaware Bay, or Delaware River (Reaches 1, 15, and 16) or for inlet, backbay, or tidal tributary shores. Erosion problems and operative coastal processes tend to be more localized along these reaches. The lower energy environment also allows for a relaxing of the requirement for strict reach-wide planning, as applicable on oceanfront reaches. The best shoreline protection approach for these areas is the planning and execution of local cost-effective projects in response to specific needs. Full consideration of low-cost erosion control measures is also appropriate. Projects following this approach have been planned by both the Corps of Engineers and the State; such projects are consistent with this Master Plan provided that their economic feasibility can be demonstrated. Recent Corps studies (USACOE, Philadelphia District, 1978) developed plans for erosion damage centers along the Delaware Bay shore, but they were found to be economically unjustified and therefore inconsistent with this Master Plan. Projects currently under consideration in this area by the State are presented along with their costs in Volume 2, Chapter VI. A similar discussion of problems, projects, and costs for other areas — including inlets, backbays, and tributary waterways — is also provided in Volume 2, Chapter VI.

**TABLE II.B-1**  
**SUMMARY OF ALTERNATIVE ENGINEERING PLANS**

Reach	(1) Storm Erosion Protection	(2) Recreational Development	(3) Combination Program	(4) Limited Restoration	(5) Maintenance
1) Raritan Bay	<ul style="list-style-type: none"> <li>o Local projects along the reach to be designed on a case by case basis. Projects can be large enough to consider beach fill. Smaller projects would consist of structural approaches such as groins, etc.</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing recreational beaches plus limited recreational development. Evaluations to be done on a case by case basis</li> </ul>	<ul style="list-style-type: none"> <li>o Local projects developed on a case by case basis</li> </ul>	<ul style="list-style-type: none"> <li>o Storm erosion protection design controls on a case by case basis</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Post storm berm repair</li> </ul>
2) Sandy Hook to Long Branch	<ul style="list-style-type: none"> <li>o 900' seawall extension</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Recreational beach on about 1/3 of reach</li> <li>o Periodic berm expansion for recreational demand</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Groin construction and modification</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Simple combination of Alternatives 1 and 2</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Beach nourishment at 10 year intervals</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Post-storm berm repair</li> </ul>
3) Long Branch to Shark River Inlet	<ul style="list-style-type: none"> <li>o 75' berm at North Long Branch and south of Deal</li> <li>o Bulkhead additions in central part of reach</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Groin construction/modifications</li> </ul>	<ul style="list-style-type: none"> <li>o No initial beach fill is required</li> <li>o Periodic berm expansion for recreational demand</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Groin modifications</li> </ul>	<ul style="list-style-type: none"> <li>o Initial beach fill for storm protection requirements</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Bulkhead additions in central third of reach</li> <li>o Periodic berm expansion</li> <li>o Groin modifications</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Initial beach fill at north and south thirds of reach to 75' berm</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Groin modifications</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Post storm berm repair</li> </ul>
4) Shark River Inlet to Manasquan Inlet	<ul style="list-style-type: none"> <li>o 75' berm along entire reach</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Groin modifications</li> </ul>	<ul style="list-style-type: none"> <li>o Existing beach if maintained will satisfy the recreational demand throughout the entire planning period</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Groin modifications</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to storm protection design</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Groin modifications</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to storm protection design</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Groin modifications</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Post-storm berm repair</li> </ul>

TABLE II.B-1 (Continued)

Reach	(1) Storm Erosion Protection	(2) Recreational Development	(3) Combination Program	(4) Limited Restoration	(5) Maintenance
5) Manasquan Inlet to Mantoloking	<ul style="list-style-type: none"> <li>o 75' berm along the groin-protected area and 100' berm elsewhere</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Existing beach if maintained will satisfy the recreational demand throughout the entire planning period</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Storm erosion protection alternative design applies here</li> </ul>	<ul style="list-style-type: none"> <li>o Beach fill to 75' at Bayhead</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair</li> </ul>
6) Mantoloking to Barnegat Inlet	<ul style="list-style-type: none"> <li>o 75' berm along the groin-protected area and 100' berm elsewhere</li> <li>o Beach nourishment at 7 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Existing beach if maintained will satisfy the recreational demand throughout the entire planning period</li> <li>o Beach nourishment at 7 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Storm erosion protection alternative design applies here</li> </ul>	<ul style="list-style-type: none"> <li>o Beach fill to 75' at Lavalette</li> <li>o Beach nourishment at 7 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair</li> </ul>
7) Long Beach Island	<ul style="list-style-type: none"> <li>o 75' berm along the entire length of the reach</li> <li>o Beach nourishment at 8 year intervals</li> <li>o Dune maintenance</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Existing beach if maintained will satisfy the recreational demand throughout the entire planning period</li> <li>o Beach nourishment at 8 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill for storm erosion protection. Storm berm satisfies recreation demand to 2030</li> <li>o Beach nourishment at 8 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Beach fill to 75' berm width at Long Beach Twp. (Holgate)</li> <li>o Beach nourishment at 8 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair</li> </ul>
8) Brigantine Island	<ul style="list-style-type: none"> <li>o 75' berm along the developed northern groin protected area and 100' berm for the southern portion of the reach</li> <li>o 10 year intervals</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Existing beach if maintained will satisfy the recreational demand through the entire planning period</li> <li>o Maintenance of existing functional structures</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill for storm erosion protection. This berm width more than satisfies recreational demand to 2030</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Beach fill to 75' berm width at northern half of developed section</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair</li> <li>o 10 year intervals</li> <li>o Maintenance of existing functional structures</li> </ul>
9) Absecon Island	<ul style="list-style-type: none"> <li>o 75' berm in groin field at northern end of island, 100' berm elsewhere</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to 400' recreational berm width in Atlantic City; tapered to 150' at Jackson Street; 150' elsewhere</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Recreational development alternative design applies here</li> </ul>	<ul style="list-style-type: none"> <li>o Beach fill to 100' berm width at Longport</li> <li>o Beach nourishment at 3 year interval</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Post storm berm repair</li> </ul>

TABLE II.B-1 (Continued)

Reach	(1) Storm Erosion Protection	(2) Recreational Development	(3) Combination Program	(4) Limited Restoration	(5) Maintenance
10) Peck Beach	<ul style="list-style-type: none"> <li>o Initial fill to 75' width in northern groin field, 100' width elsewhere</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Groin construction/modification</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill for recreational beach at northern end of island</li> <li>o Periodic berm expansion</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill for storm protection design</li> <li>o Periodic beach expansions for recreation at northern public access area</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to storm berm design at northern portion of island</li> <li>o Beach nourishment at 5 year intervals</li> <li>o Periodic berm expansion at 5 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair 5 year intervals</li> </ul>
11) Ludlam Island	<ul style="list-style-type: none"> <li>o Initial fill to 75' width in the Sea Isle City groin field with 100' width elsewhere</li> <li>o Groin field extension to south end of island</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Existing beach if maintained will satisfy the recreational demand through the entire planning period</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Dune maintenance</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill for storm protection design</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Dune maintenance</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to storm protection design for Strathmere and northern portion of Sea Isle City</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Dune maintenance</li> <li>o Maintenance of existing functional structures</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair</li> </ul>
12) Seven Mile Beach	<ul style="list-style-type: none"> <li>o Initial fill to 75' in Stone Harbor groin field, 100' width elsewhere</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o No initial fill is required</li> <li>o Periodic berm expansion</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to storm protection design</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to 75' wide berm in Stone Harbor groin field</li> <li>o Beach nourishment at 10 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair</li> </ul>
13) Five Mile Beach	<ul style="list-style-type: none"> <li>o Initial fill to minimum of 100' berm width</li> <li>o Beach nourishment at the end of the 50 year period</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Existing beach if maintained will satisfy the recreational demand throughout the entire planning period</li> <li>o Beach nourishment at the end of the 50 year period</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill for storm protection design</li> <li>o Beach nourishment at the end of the 50 year period</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to 100' wide berm at Wildwood Crest area</li> <li>o Beach nourishment at the end of the 50 year period</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair</li> </ul>

TABLE II.B-1 (Continued)

Reach	(1) Storm Erosion Protection	(2) Recreational Development	(3) Combination Program	(4) Limited Restoration	(5) Maintenance
14) Cape May Inlet to Cape May Point	<ul style="list-style-type: none"> <li>o 75' berm width at Cape May City and Cape May Point groin fields, 100' berm width elsewhere</li> <li>o Modification of structures in Lower Township and at northern portion of the reach to stabilize beach by equilibrium crenulate-shaped bays</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill for recreational beach at Cape May City and Cape May Point</li> <li>o Periodic berm expansion</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Modification of structures in Lower Township and at northern portion of the reach to stabilize beach</li> </ul>	<ul style="list-style-type: none"> <li>o Storm erosion protection alternative design applies here</li> </ul>	<ul style="list-style-type: none"> <li>o Initial fill to 75' berm width Cape May City and Cape May Point groin fields</li> <li>o Beach nourishment at 3 year intervals</li> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Modification of structures in Lower Township and at northern portion of the reach to stabilize beach</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures</li> <li>o Dune maintenance</li> <li>o Post storm berm repair</li> </ul>
15) and 16) Delaware Bay and River	<ul style="list-style-type: none"> <li>o Local projects to be designed on a case by case basis. Projects predominantly of a structural nature (bulk-heading, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>o Insufficient demand to justify any actions to develop recreational beach area any time during the planning period</li> </ul>	<ul style="list-style-type: none"> <li>o Storm erosion protection program controls on a case by case basis as justified</li> </ul>	<ul style="list-style-type: none"> <li>o Engineering programs on a case by case basis as justified</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures on a case by case basis as justified</li> </ul>
Backbay and Tributary Waterway Shores	<ul style="list-style-type: none"> <li>o Local projects to be designed on a case by case basis. Projects predominantly of a structural nature (bulk-heading, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>o Insufficient demand to justify any actions to develop recreational beach area any time during the planning period</li> </ul>	<ul style="list-style-type: none"> <li>o Storm erosion protection program controls on a case by case basis as justified</li> </ul>	<ul style="list-style-type: none"> <li>o Engineering programs on a case by case basis as justified</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional structures on a case by case basis as justified</li> </ul>
Inlets	<ul style="list-style-type: none"> <li>o Projects predominantly of a structural nature such as jetty construction, revetment and bulkhead construction, and groin stabilization of inlet shores, to be designed on a case by case basis for the following inlets: Shark River, Barnegat, Absecon, Great Egg Harbor, Townsends, and Hereford</li> <li>o Maintenance of the existing functional inlet structures on a case by case basis as justified</li> <li>o For the following inlets, no action is proposed and shores will be left in their natural state. They include Beach Haven, Little Egg, and Brigantine Inlets</li> </ul>	<ul style="list-style-type: none"> <li>o None</li> </ul>	<ul style="list-style-type: none"> <li>o None</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance program controls</li> </ul>	<ul style="list-style-type: none"> <li>o Maintenance of existing functional inlet structures on a case by case basis as justified</li> <li>o For the following inlets, no action is proposed and shores will be left in their natural state. They include Beach Haven, Little Egg, and Brigantine Inlets</li> </ul>

TABLE II.B-2

SUMMARY OF ESTIMATED COST FOR  
ALTERNATIVE ENGINEERING PLANS FOR OCEANFRONT REACHES

Reach No.	Reach Name	Alternatives*	Estimated** Total Present Worth Cost (in million dollars)	Initial Cost** (in million dollars)	Annual Cost (in million dollars)
2	Sandy Hook to Long Branch	(1)	10.402	5.509	0.446
		(2)	23.689	15.912	0.386
		(3)	26.187	17.712	0.449
		(4)	8.578	3.709	0.444
		(5)	4.482	3.709	0.071
3	Long Branch to Shark River Inlet	(1)	41.272	32.399	0.810
		(2)	21.495	11.270	0.933
		(3)	40.232	31.010	0.841
		(4)	28.837	19.891	0.816
		(5)	11.883	11.170	0.065
4	Shark River Inlet to Manasquan Inlet	(1)	29.876	20.286	0.875
		(2)	13.164	3.574	0.875
		(3)	29.876	20.286	0.875
		(4)	29.876	20.286	0.875
		(5)	3.598	3.424	0.016
5	Manasquan Inlet to Mantoloking	(1)	12.401	8.658	0.341
		(2)	4.271	0.528	0.341
		(3)	12.401	8.658	0.341
		(4)	7.357	3.614	0.341
		(5)	0.602	0.528	0.007
6	Mantoloking to Barnegat Inlet	(1)	21.750	14.588	0.853
		(2)	7.870	0.708	0.653
		(3)	21.750	14.588	0.853
		(4)	12.725	5.563	0.653
		(5)	0.944	0.708	0.021
7	Long Beach Island	(1)	28.496	20.813	0.701
		(2)	11.321	3.638	0.701
		(3)	28.496	20.813	0.701
		(4)	14.153	6.470	0.701
		(5)	5.149	3.638	0.138
8	Brigantine Island	(1)	13.297	9.373	0.358
		(2)	4.649	0.702	0.360
		(3)	13.297	9.373	0.358
		(4)	12.308	8.384	0.358
		(5)	0.980	0.702	0.025
9	Absecon Island	(1)	25.279	8.044	1.572
		(2)	28.741	11.506	1.572
		(3)	28.741	11.506	1.572
		(4)	23.018	5.687	1.581
		(5)	3.487	3.302	0.017
10	Peck Beach	(1)	30.708	19.523	1.020
		(2)	17.573	3.447	1.289
		(3)	30.504	17.203	1.213
		(4)	21.617	10.368	1.026
		(5)	1.007	0.653	0.032
11	Ludlam Island	(1)	42.409	22.248	1.839
		(2)	20.687	0.501	1.841
		(3)	42.409	22.248	1.839
		(4)	28.511	8.381	1.836
		(5)	0.795	0.501	0.027
12	Seven Mile Beach	(1)	18.724	14.402	0.394
		(2)	7.711	0.700	0.640
		(3)	18.724	14.402	0.394
		(4)	12.963	8.641	0.394
		(5)	0.959	0.700	0.024
13	Five Mile Beach	(1)	4.150	3.945	0.019
		(2)	0.973	0.752	0.020
		(3)	4.150	3.945	0.019
		(4)	3.244	3.039	0.019
		(5)	0.911	0.752	0.014
14	Cape May Inlet to Cape May Point	(1)	35.837	15.888	1.820
		(2)	31.740	9.808	1.820
		(3)	35.837	15.888	1.820
		(4)	34.263	14.314	1.820
		(5)	1.497	1.004	0.045

\*Alternative engineering plans are: (1) Storm Erosion Protection; (2) Recreational Development; (3) Combination of Storm Protection and Recreational Development; (4) Limited Restoration; and (5) Maintenance Program.

\*\*Cost estimate details are provided for all alternatives in Volume 2, Chapter VI.

d. Priority Analysis of Alternative Engineering Plans

(1) Summary of Methodology. Three primary factors were considered in the selection of priority engineering projects:

- o The relative ranking of reach alternative plans based on the non-incremental benefit-to-cost ratios.
- o Total costs.
- o Existing maintenance commitments to completed Federal projects.

The benefit-to-cost ratio for a given alternative was derived from four input parameters — engineering costs, public service costs, recreational benefits, and property protection benefits. For each reach, this ratio was computed for the five engineering plans.

All costs and benefits are expressed in present worth values with a rate of return of 9 percent for the 50-year planning period. A present worth value accounts for the effect of time on a future economic activity. The time value of money (opportunity to use funds during the intervening period in an alternative manner) is recognized. The future benefits or costs are converted to equivalent present day dollars by discounting at a given rate of return. The priority analysis used the net present worth approach as opposed to an average annualized value approach. It was felt that the net present worth approach was more applicable to the uneven temporal distribution of the benefits and costs observed in this analysis (i.e., low annual benefits occur early in the planning period, and large annual benefits occur later in the planning period).

(2) Cost-Benefit Analysis for Alternative Reach Plans. The cost-benefit analysis involves determination of a non-incremental benefit-to-cost ratio for each of the five alternative engineering plans for each of the oceanfront reaches. Figure II.B-3 illustrates the procedures involved. A brief explanation of the four input parameters is presented below; a more detailed discussion is provided in Volume 2, Chapter VII. The costs and benefits for each oceanfront reach alternative are summarized in Table II.B-3.

(a) Engineering Costs. Engineering costs are expressed in present worth values, including component costs pertaining to each alternative plan. Typical items are initial beach fill, periodic berm width expansion, beach nourishment and structural maintenance. These components are required to achieve a specific level of protection or development throughout the project design life.

(b) Public Service Costs. Public service costs are an estimate of the demands generated by beach users on a local area for recreation-related services (lifeguards, beach maintenance, etc.) and for additional infrastructure capacity. This estimate was computed on a per capita basis to take into account the additional public services costs that would be incurred by the communities within a reach as a result of the additional beach users anticipated. The total cost was calculated in present value dollars to be comparable to other costs and benefits. The per capita public service cost was estimated to be \$1.00 per beach user.

(c) Recreational Benefits. Recreational benefits, expressed in present worth values, represent the benefits from an increase in visitors to the beach as a result of additional beach areas being provided for recreational use. The recreational benefit was estimated using a unit opportunity cost figure of \$2.00 per additional beach user accommodated.

## PROCEDURES FOR COST-BENEFIT ANALYSIS

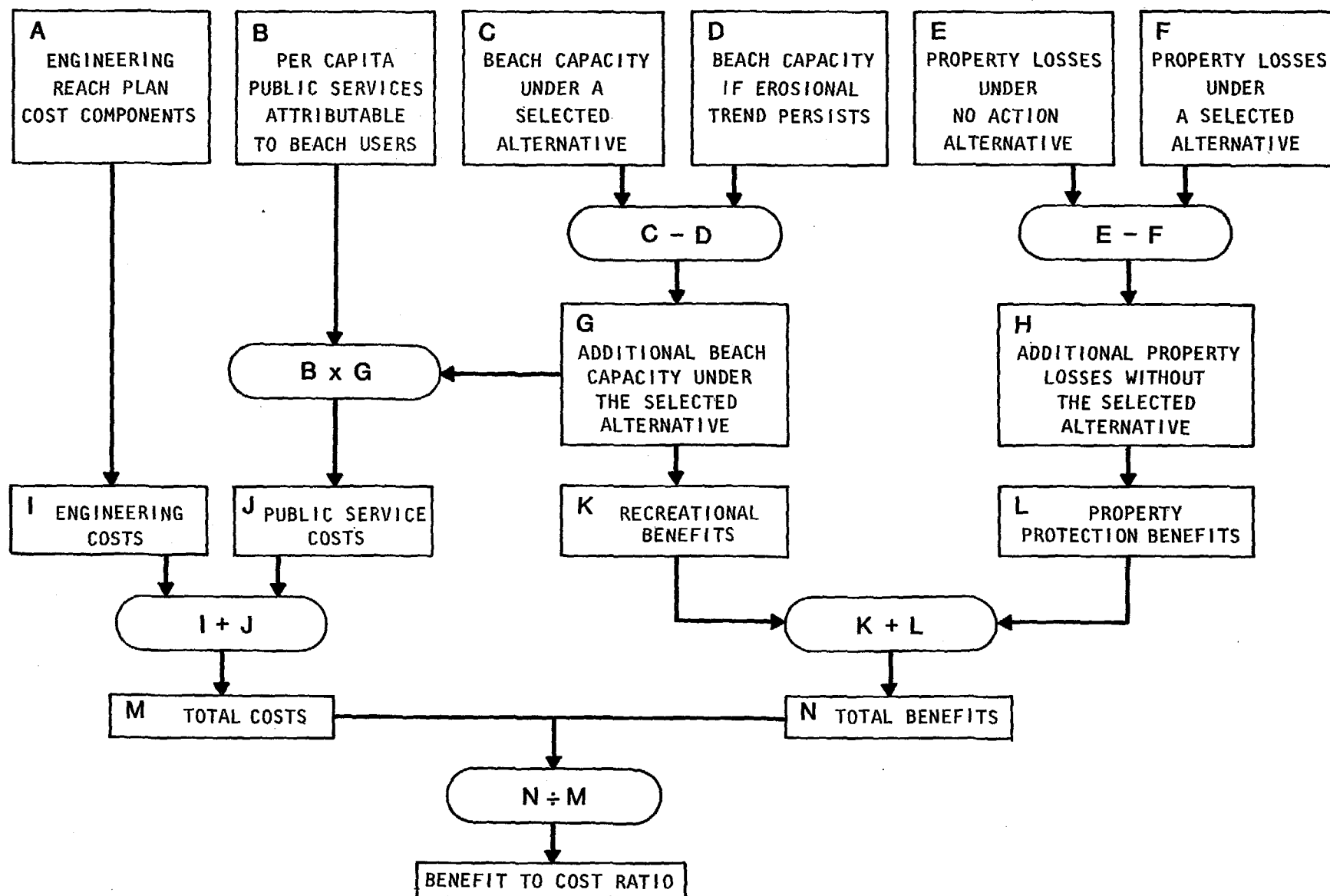


TABLE II.B-3

COST-BENEFIT ANALYSIS FOR OCEANFRONT REACHES (2-14)<sup>(a)</sup>

Reach No.	Reach Name	Erosion Control Alternatives <sup>(b)</sup>	Engineering Cost (in million dollars)	Public Service Cost (in million dollars)	Recreational Benefits (in million dollars)	Property Protection (in million dollars)	Benefit/Cost Ratio	Relative Rank <sup>(c)</sup>
2	Sandy Hook to Long Branch	(1)	10.402	5.081	10.163	7.280	1.13	13
		(2)	23.689	9.709	19.418	7.209	0.80	18
		(3)	26.187	9.709	19.418	7.280	0.74	22
		(4)	8.578	5.081	10.163	7.209	1.27	9
		(5)	4.482	0	0	6.755	1.51	3
3	Long Branch to Shark River Inlet	(1)	41.272	10.384	20.769	4.383	0.49	30
		(2)	21.495	4.140	8.280	4.360	0.49	25
		(3)	40.232	10.477	20.954	4.383	0.50	27
		(4)	28.837	6.932	13.864	4.383	0.51	26
		(5)	11.883	0	0	1.579	0.13	43
4	Shark River Inlet to Manasquan Inlet	(1)	29.876	7.502	15.004	2.481	0.47	32
		(2)	13.164	5.234	10.468	2.479	0.70	23
		(3)	29.876	7.502	15.004	2.487	0.47	32
		(4)	29.876	7.502	15.004	2.487	0.47	32
		(5)	3.598	0	0	0.566	0.16	41
5	Manasquan Inlet to Mantoloking	(1)	12.401	0.374	0.749	2.161	0.23	39
		(2)	4.271	0.374	0.749	2.161	0.63	25
		(3)	12.401	0.374	0.749	2.161	0.23	39
		(4)	7.357	0.374	0.749	2.161	0.38	35
		(5)	0.602	0	0	0.050	0.08	47
6	Mantoloking to Barnegat Inlet	(1)	21.750	0.203	0.406	2.704	0.14	42
		(2)	7.870	0.203	0.406	2.697	0.38	36
		(3)	21.750	0.203	0.406	2.704	0.14	42
		(4)	12.725	0.203	0.406	2.697	0.24	37
		(5)	0.944	0	0	0.100	0.10	44
7	Long Beach Island	(1)	28.496	4.306	8.612	6.894	0.47	31
		(2)	11.321	3.905	7.810	6.894	0.96	15
		(3)	28.496	4.306	8.612	6.894	0.47	31
		(4)	14.153	4.047	8.094	6.894	0.82	17
		(5)	5.149	0	0	1.183	0.23	38
8	Brigantine Island	(1)	13.297	0.257	0.515	0.352	0.06	49
		(2)	4.649	0.257	0.515	0.352	0.17	40
		(3)	13.297	0.257	0.515	0.352	0.06	49
		(4)	12.308	0.257	0.515	0.352	0.07	48
		(5)	0.980	0	0	0.035	0.04	50
9	Absecon Island	(1)	25.279	50.456	100.911	2.328	1.36	8
		(2)	28.741	71.165	142.330	2.328	1.45	4
		(3)	28.741	71.165	142.330	2.328	1.45	4
		(4)	23.018	26.698	53.397	2.328	1.12	14
		(5)	3.487	0	0	0	0	54
10	Peck Beach	(1)	30.708	43.898	87.696	17.925	1.41	6
		(2)	17.573	42.431	84.861	17.198	1.70	1
		(3)	30.504	43.867	87.734	17.925	1.42	5
		(4)	21.617	43.184	86.387	17.193	1.60	2
		(5)	1.007	0	0	1.187	1.18	11
11	Ludlam Island	(1)	42.409	8.460	16.921	8.584	0.50	28
		(2)	20.687	8.460	16.921	8.584	0.88	16
		(3)	42.409	8.460	16.921	8.584	0.50	28
		(4)	28.511	8.460	16.921	8.584	0.69	24
		(5)	0.795	0	0	0.349	0.44	33
12	Seven Mile Beach	(1)	18.724	24.448	48.896	0.514	1.14	12
		(2)	7.711	16.097	32.193	0.402	1.37	7
		(3)	18.724	24.448	48.896	0.514	1.14	12
		(4)	12.963	21.974	43.949	0.402	1.27	10
		(5)	0.959	0	0	0.092	0.10	45
13	Five Mile Beach	(1)	4.150	0.052	0.103	0	0.02	52
		(2)	0.973	0.052	0.103	0	0.10	46
		(3)	4.150	0.052	0.103	0	0.02	52
		(4)	3.244	0.052	0.103	0	0.03	51
		(5)	0.911	0	0	0	0	53
14	Cape May Inlet to Cape May Point	(1)	35.837	22.196	44.393	0.754	0.78	21
		(2)	31.740	20.324	40.648	0.754	0.80	19
		(3)	35.837	22.196	44.393	0.754	0.78	21
		(4)	34.263	22.196	44.393	0.754	0.80	20
		(5)	1.497	0	0	0.571	0.38	34

Note: See text for cost-benefit methodology discussion.

(a) All estimated costs and benefits are expressed in present worth values.

(b) Alternative engineering plans are: (1) Storm Erosion Protection; (2) Recreational Development; (3) Combination of Storm Protection and Recreational Development; (4) Limited Restoration; and (5) Maintenance Program

(c) For alternatives with identical benefit/cost ratios, the one with the lower total cost was given priority over the others.

(d) Property Protection Benefits. Property protection benefits, expressed in present worth values, represent the benefits achieved under an engineering alternative plan in prevention of property loss associated with storm erosion and long-term erosional damages. The benefits credited to an engineering plan include the values of probable losses to commercial and residential lands and structures (including commercial and residential buildings, boardwalks, roads, and utilities) that could occur if no action is taken. The present worth property protection benefits are derived from cognizance of the capability of a beach area to retard the occurrence of erosional and storm damages. Since the beach area forms the first line of protection against erosion, damages would occur earlier in the property zone areas fronted by a narrow beach than in those areas protected by a wide beach.

## 2. Adopted Engineering Plans.

### a. Adopted Priority List for the Ocean Shore

Priority recommendation for reach engineering projects is primarily dependent on the benefit-to-cost (B/C) ratios. Component present worth costs and benefits for the alternative engineering plans for oceanfront reaches are presented in Table II.B-3. Table II.B-4 shows the relative ranking for all five engineering alternatives in the 13 oceanfront reaches. Engineering projects which are the most cost beneficial in each reach are presented in ranked order in Table II.B-5.

From Table II.B-5, those alternative projects which are clearly the most cost beneficial include:

- o Peck Beach, Recreational (1.70 B/C ratio)
- o Sandy Hook to Long Branch, Maintenance (1.51 B/C ratio)
- o Absecon Island, Recreational (1.44 B/C ratio)
- o Seven Mile Beach, Recreational (1.37 B/C ratio).

A reach project that was marginally cost beneficial was:

- o Long Beach Island, Recreational (0.96 B/C ratio)

The remaining reach projects are not clearly cost beneficial.

In setting priorities, consideration was also given to maintenance of completed Federal projects. State and local governments have executed assurances that the completed Federal projects will be maintained throughout their 50-year economic lives. Honoring of these contractual assurances is essential to prevent forfeiture of future Federal funds for water resources projects. The completed Federal projects are located in the Keansburg area along the Raritan Bayshore (Reach 1), in Long Beach Island (Reach 7), and on Absecon Island (Reach 9).

One of the advantages of Federal participation in shore protection projects is that the Corps can restore the beach to project levels if it is destroyed by a major storm. This added "insurance" would apply to the completed Federal Long Beach Island and Atlantic City projects only if the State maintains those projects. Since the proposed Master Plan alternatives for Long Beach Island and Absecon Island (Atlantic City) would provide for the required maintenance necessary to satisfy the Corps agreements for these projects, the added "insurance" provided by this plan is an additional "benefit." Thus, based on this consideration, the Long Beach Island recreational

TABLE II.B-4

RELATIVE RANKING OF REACH ENGINEERING PROJECTS BY BENEFIT/COST RATIO  
ALL REACH ENGINEERING ALTERNATIVES FOR OCEANFRONT REACHES

Relative Rank	Reach and Alternative**	Benefits* Cost Ratio
1	Peck Beach (10) - Recreational Development	1.70
2	Peck Beach (10) - Limited Restoration	1.60
3	Sandy Hook to Long Branch (2) - Maintenance Program	1.51
4	Absecon Island (9) - Recreational Development or Combination Alternative	1.45
5	Peck Beach (10) - Storm Erosion Protection	1.41
6	Peck Beach (10) - Combination Alternative	1.42
7	Seven Mile Beach (12) - Recreational Development	1.37
8	Absecon Island (9) - Storm Erosion Protection	1.36
9	Sandy Hook to Long Branch (2) - Limited Program	1.27
10	Seven Mile Beach (12) - Limited Restoration	1.27
11	Peck Beach (10) - Maintenance Program	1.18
12	Seven Mile Beach (12) - Storm Erosion Protection or Combination Alternative	1.14
13	Sandy Hook to Long Branch (2) - Storm Erosion Protection	1.13
14	Absecon Island (9) - Limited Restoration	1.12
15	Long Beach Island (7) - Recreational Development	0.96
16	Ludlam Island (11) - Recreational Development	0.88
17	Long Beach Island (7) - Limited Restoration	0.82
18	Sandy Hook to Long Branch (2) - Recreational Development	0.80
19	Cape May Inlet to Cape May Point (14) - Recreational Development	0.80
20	Cape May Inlet to Cape May Point (14) - Limited Restoration	0.80
21	Cape May Inlet to Cape May Point (14) - Storm Erosion Protection or Combination Alternative	0.78
22	Sandy Hook to Long Beach (2) - Combination Alternative	0.74
23	Shark River Manasquan Inlet (2) - Recreational Development	0.70
24	Ludlam Island (11) - Limited Restoration	0.69
25	Manasquan Inlet to Mantoloking (5) - Recreational Development	0.63
26	Long Branch to Shark River Inlet (3) - Limited Restoration	0.51
27	Long Branch to Shark River Inlet (3) - Combination Alternative	0.50
28	Ludlam Island (11) - Storm Erosion Protection or Combination Alternative	0.50
29	Long Branch to Shark River Inlet (3) - Recreational Development	0.49
30	Long Branch to Shark River Inlet (3) - Storm Erosion Protection	0.49
31	Long Beach Island (7) - Storm Erosion Protection or Combination Alternative	0.47
32	Shark River Inlet to Manasquan Inlet (4) - Storm Erosion Protection or Combination or Limited Restoration	0.47
33	Ludlam Island (11) - Maintenance Program	0.44
34	Cape May Inlet to Cape May Point (14) - Maintenance Program	0.38
35	Manasquan Inlet to Mantoloking (5) - Limited Restoration	0.38
36	Mantoloking to Barnegat Inlet (6) - Recreational Development	0.38
37	Mantoloking to Barnegat Inlet (6) - Limited Restoration	0.24
38	Long Beach Island (7) - Maintenance Program	0.23
39	Manasquan Inlet to Mantoloking (5) - Storm Erosion Protection or Combination Alternative	0.23
40	Brigantine Island (8) - Recreational Development	0.17
41	Shark River Inlet to Manasquan Inlet (4) - Maintenance Program	0.16
42	Mantoloking to Barnegat Inlet (6) - Storm Erosion Protection or Combination Alternative	0.14
43	Long Beach to Shark River Inlet (3) - Maintenance Program	0.13
44	Mantoloking to Barnegat Inlet (6) - Maintenance Program	0.10
45	Seven Mile Beach (12) - Maintenance Program	0.10
46	Five Mile Beach (13) - Recreational Development	0.10
47	Manasquan Inlet to Mantoloking (5) - Maintenance Program	0.08
48	Brigantine Island (8) - Limited Restoration	0.07
49	Brigantine Island (8) - Storm Erosion Protection or Combination Alternative	0.06
50	Brigantine Island (8) - Maintenance Program	0.04
51	Five Mile Beach (13) - Limited Restoration	0.03
52	Five Mile Beach (13) - Storm Erosion Protection or Combination Alternative	0.02
53	Five Mile Beach (13) - Maintenance Program	0
54	Absecon Island (9) - Maintenance Program	0

## Note:

\* For alternatives with identical benefit/cost ratios, the one with the lower total present worth cost was given priority over the others.

\*\* The number in parentheses refers to the reach number.

TABLE II.B-5

RELATIVE PRIORITY RANKING BY BENEFIT/COST RATIO  
HIGHEST RANKING ENGINEERING ALTERNATIVE FOR EACH REACH

Reach No.	Reach/Alternative	Relative Rank	Benefit/ Cost Ratio	Initial Cost (in million dollars)	Estimated Total Present Worth Cost (in million dollars)
10	Peck Beach Recreational Development	1	1.70	3.447	17.573
2	Sandy Hook to Long Branch Maintenance Program	2	1.51	3.709	4.482
9	Absecon Island Recreational Development or Combination	3	1.45	11.506	28.741
12	Seven Mile Beach Recreational Development	4	1.37	0.700	7.711
7	Long Beach Island Recreational Development	5	0.96	3.638	11.321
11	Ludlam Island Recreational Development	6	0.88	0.501	20.687
14	Cape May to Cape May Point Recreational Development	7	0.80	9.808	31.740
4	Shark River Inlet to Manasquan Inlet Recreational Development	8	0.70	3.574	13.164
5	Manasquan Inlet to Mantoloking Recreational Development	9	0.63	0.528	4.271
3	Long Branch to Shark River Inlet Limited Restoration	10	0.51	19.891	28.837
6	Mantoloking to Barnegat Recreational Development	11	0.38	0.708	7.870
8	Brigantine Island Recreational Development	12	0.17	0.702	4.649
13	Five Mile Beach Recreational Development	13	0.10	0.752	0.973

## Notes:

- Each of the nonmaintenance alternatives may include maintenance as a component, e.g., the total cost for the Peck Beach recreational development alternative includes \$1.007 million of maintenance plus \$16.566 million of additional costs above and beyond maintenance, for a total cost of \$17.573 million. Details of cost estimates for each reach alternative are presented in Volume 2, Chapter VI.
- In reaches where two, preferred, non-maintenance alternatives had identical benefit/cost ratios, the lower total present value cost among the two alternatives was entered in the table.

alternative has been added to the list of clearly beneficial projects. The Absecon Island plan is economically justifiable on its own, and its implementation avoids the violation of the assurances given on this project.

Based on the considerations above, the recommended priority reach engineering plans are those listed in Table II.B-6.

TABLE II.B-6  
PRIORITY ENGINEERING REACH PLANS FOR THE OCEAN SHORE

<u>Reach No.</u>	<u>Reach Name</u>	<u>Alternative</u>
10	Peck Beach	Recreational Development
2	Sandy Hook to Long Branch	Maintenance Program
9	Absecon Island	Recreational Development
12	Seven Mile Beach	Recreational Development
7	Long Beach Island	Recreational Development

Maintenance of the Federal Keansburg area project is not explicitly included in the recommended priority list. Provision is made for its implementation in that the Raritan Bay projects are recommended pending evaluation on a case-by-case basis. The preservation of future Federal funding and the storm restoration "benefit" tend to favor this project.

**b. Preferred Reach Engineering Plans**

The following sections summarize the engineering recommendations for each of the 16 shoreline reaches as well as for inlets, backbays, and other shore areas. For reaches where alternative reach engineering alternatives were not found to be economically justified, general recommendations for less-than-reach projects have been provided. A discussion of the most cost beneficial of the reach-level alternatives evaluated has also been provided for these reaches. The DEP will consider implementation of these plans with available funds in the order of relative priority ranking provided in Table II.B-4.

The individual plans summarized here are presented in detail in Volume 2, Chapter VI. The assumptions and criteria used in development of engineering plans are presented above in Section II.B.1.

(1) The Plan For Reach 1 — Raritan Bay. It is recommended that a general program including maintenance of functional structures and recreational beaches be followed along the Raritan Bay Shore. Case-by-case evaluation of local nonstructural and structural projects will consider both the local needs to be served and the overall economic feasibility of these projects. Special consideration will be given to Old Bridge Township, Keansburg, and Middletown Township beach areas. These areas have

completed Federal shore protection projects. Their continued maintenance would satisfy assurances executed by the State and local governments regarding upkeep and would prevent the forfeiture of future Federal cost sharing for similar projects elsewhere.

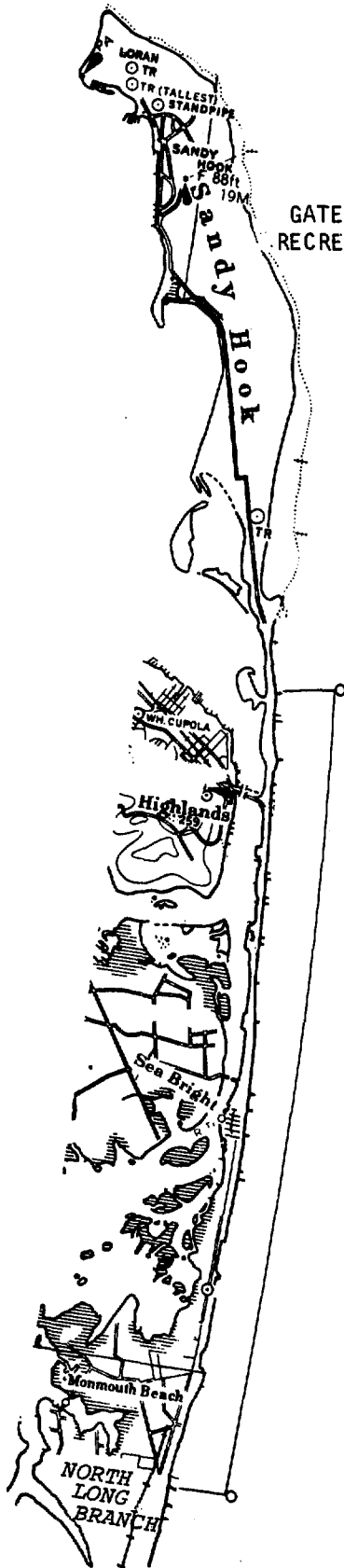
(2) The Plan For Reach 2 - Sandy Hook to Long Branch. It is recommended that a program of maintenance of existing functional shore protection structures be followed in this reach. The Maintenance Program would include initial structural repairs to the seawall and functional groins to bring these structures up to a uniform level of repair. The initial maintenance cost estimate provided in Table II.B-7 is for repairs to 16 groins and about 2300 feet of seawall. Subsequently a program of periodic maintenance of the seawall and existing groins would be undertaken throughout the economic life of the program to ensure their integrity. Repair of future severe storm erosion damage to beach berms is also recommended.

Initial structural repairs for Reach 2 are estimated to cost \$3,709,000. The subsequent maintenance would average about \$71,000 annually. No cost estimates are provided for the repair of storm damaged beaches because of the unpredictability of such occurrences. However, contingency funding would be made available to repair such damage when it occurs.

TABLE II.B-7  
COST ESTIMATE SUMMARY  
MAINTENANCE PROGRAM  
REACH 2 - SANDY HOOK TO LONG BRANCH

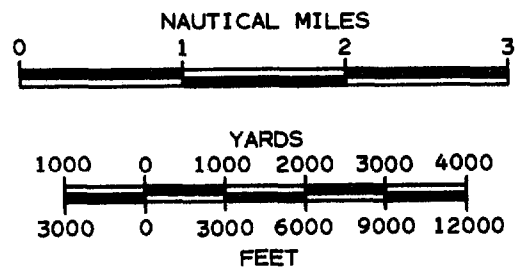
<u>Cost Components</u>	<u>Estimated Initial Costs</u>	<u>Estimated Present Worth Cost Totals</u>
<u>Initial Structural Maintenance</u>		
o Repairs to 16 groins and 2300 L.F. of stone seawall	\$ 3,709,000	\$ 3,709,000
<u>Maintenance of Existing Functional Structures</u>		
o 24,250 L.F. of seawall		674,000
o 16 groins		99,000
<u>TOTALS</u>	<u>\$ 3,709,000</u>	<u>\$ 4,482,000</u>

The southern portion of Sandy Hook is critically eroding and there is an imminent threat of seawall failure and breaching of the island along the narrow neck of the Hook adjacent to Sea Bright. The plan for this reach does not provide a remedial engineering program for Sandy Hook because the area is Federally owned and under the administration of the National Park Service (see Figure II.B-4). The Maintenance Program recommended for Sea Bright and Monmouth Beach should not further aggravate the erosion problems at Sandy Hook.



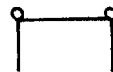
GATEWAY NATIONAL  
RECREATIONAL AREA

## REACH 2 - SANDY HOOK TO LONG BRANCH



### RECOMMENDED PLAN

#### MAINTENANCE PROGRAM



MAINTENANCE OF THE EXISTING  
FUNCTIONAL STRUCTURES

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The recommended plan provides the badly needed repair and maintenance of the seawall. The program would keep the seawall in functional form during the planning period, but it is not a permanent solution. Without the provision of nourishment sands seaward of the wall, the offshore profile will continue to steepen. Localized failures of the wall during a future storm event are inevitable even with the maintenance provided under the recommended alternative. Analysis indicates that the wall will not be totally undermined during the 50-year planning period.

In the cost benefit analysis for the alternative engineering plans for Reach 2, three of the five alternatives evaluated were found to be clearly cost beneficial. The benefit/cost ratios (B/C ratio) and total present worth cost of these alternatives are as follows:

Maintenance Program	1.51	\$4.5 million
Limited Restoration	1.27	\$8.6 million
Storm Erosion Protection	1.13	\$10.4 million

The Limited Restoration and Storm Erosion Protection alternatives include a provision for beach nourishment for stabilization of the erosion problem and the seawall deterioration. However, in accordance with the policy of implementing the most cost beneficial (highest priority) plan for each reach, the Maintenance Program is the preferred alternative for Reach 2. This also happens to be the lowest cost alternative for Reach 2.

Implementation of the Limited Restoration or Storm Erosion Protection alternatives would be more difficult for several key reasons.

- o The relative rank of these projects is substantially lower with respect to the priorities of all reach engineering plans (see Table II.B-4);
- o Since the total present worth cost of these alternatives is about double the cost of the Maintenance Program, the required local cost share would be twice as much; and
- o State and Federal policies allow cost sharing in beach restoration and improvement projects only where adequate public access is provided. Since the shorefront of Reach 2 municipalities of Seabright and Monmouth Beach are predominantly privately-owned and controlled, public access to most beaches is restricted. Unless current public access restriction are substantially reduced, State and Federal funding of the necessary beach nourishment programs would be unlikely.

Considering these factors and the fact that structural maintenance can be undertaken on a less-than-reach basis if necessary, the Maintenance Program is clearly the preferred alternative for Reach 2.

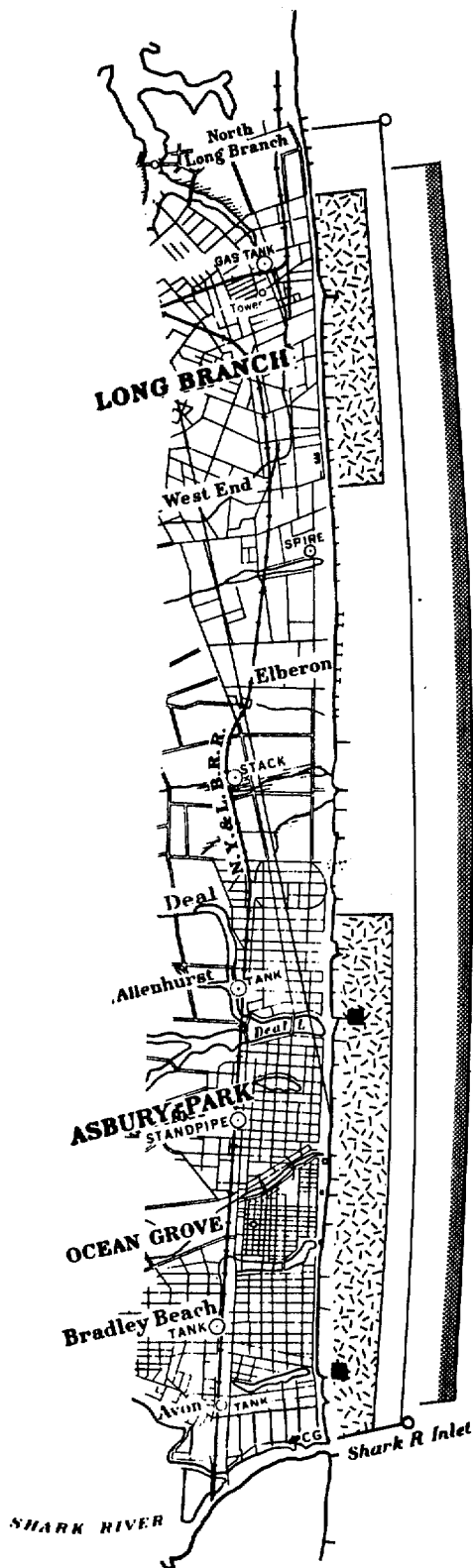
(3) The Plan For Reach 3 — Long Branch to Shark River Inlet. The priority analysis has shown that none of the reach-level engineering alternatives evaluated for Reach 3 are economically justifiable. Therefore, none of these engineering plans are recommended on a priority basis. It is, however, recommended that a limited program of maintenance and/or modification of existing functional shore protection structures be adopted to mitigate local erosion problems. Local projects are conditionally acceptable under this plan if they can be shown to adequately address the needs of the

area, they do not create adverse effects in adjacent shore areas, and can be shown to be economically feasible in case-by-case evaluations.

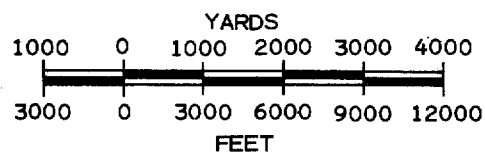
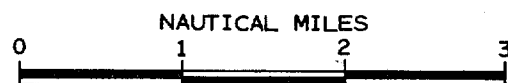
Modification of selected high profile groins which act as major littoral barriers would be appropriate to relieve local beach starvation effects. Consideration of sand bypassing across Shark River Inlet is also a possibility. However, this would provide only limited relief of beach erosion at the southern end of the reach. There is insufficient sand available for bypassing to adequately supply the entire reach. Consideration would also have to be given to potential adverse effects to the beach at Belmar, on the south side of the inlet.

Of the alternative reach engineering plans evaluated for Reach 3, the most cost beneficial plan was the Limited Restoration alternative. However, this alternative only has a benefit/cost ratio of 0.51. The components of the cost estimate and present worth cost totals are summarized in Table II.B-8. As illustrated in Figure II.B-5, the Limited Restoration alternative includes beach fills in public access areas in the northern and southern portions of the reach. Beach nourishment from offshore sources is provided at 5-year intervals for maintenance of beach width where required. The Limited Restoration plan also calls for notching, lowering, or otherwise modifying two groins (one located at the northern end of Avon (Sylvan Lake) and the other located south of Deal Lake) to relieve sand starvation effects on adjacent downdrift sand beaches. Initial maintenance of existing functional shore protection structures is provided to bring them up to a uniform level of repair throughout the reach. This work would include repair of 41 groins, approximately 4000 linear feet of timber bulkhead, and 450 linear feet of seawall. Periodic maintenance of all functional structures, including 64 groins, 1350 linear feet of shore seawall and more than 6000 linear feet of timber and steel bulkhead, is included to ensure their functional integrity throughout the economic life of the project.

The recommended minimum program of local maintenance and/or modification of existing functional shore protection structures on a case-by-case basis would be consistent with maintenance components of the Limited Restoration alternative for Reach 3.



## REACH 3 - LONG BRANCH TO SHARK RIVER INLET

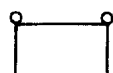

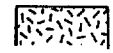



### RECOMMENDED PLAN

MAINTENANCE AND/OR MODIFICATION OF  
EXISTING FUNCTIONAL STRUCTURES ON  
AN AS NEEDED, CASE-BY-CASE BASIS

### MOST COST BENEFICIAL REACH ALTERNATIVE

#### LIMITED RESTORATION PROGRAM

-  MAINTENANCE OF THE EXISTING  
FUNCTIONAL STRUCTURES
-  PERIODIC BEACH NOURISHMENT
-  BEACH FILL TO A BERM WIDTH OF  
75 FEET (BEACH WIDTH OF 215 FEET)
-  GROIN MODIFICATION

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TABLE II.B-8

COST ESTIMATE SUMMARY  
LIMITED RESTORATION PROGRAM  
REACH 3 - LONG BRANCH TO SHARK RIVER INLET

<u>Cost Components</u>	<u>Estimated Initial Costs</u>	<u>Estimated Present Worth Cost Totals</u>
<u>Beach Fill</u>		
o Beach fill in public access areas to 75' berm width (215' beach width) Initial fill: 1,192,000 cu. yd.	\$ 8,621,000	\$ 8,621,000
<u>Beach Nourishment</u>		
o 845,000 cu. yd. at 5-year intervals		8,430,000
<u>Structural Modifications</u>		
o Notching or lowering of 2 groins	100,000	100,000
<u>Initial Structural Maintenance</u>		
o Repairs to 41 groins, 4000 L.F. of timber bulkhead and 450 L.F. of seawall	11,170,000	11,170,000
<u>Maintenance of Existing Functional Structures</u>		
o 5700 L.F. of timber bulkhead in Long Branch		76,000
o 1350 L.F. of stone seawall in Deal		36,000
o 500 L.F. of steel bulkhead in Deal		7,000
o 64 groins		397,000
<u>TOTALS</u>	<u>\$ 19,891,000</u>	<u>\$ 28,837,000</u>

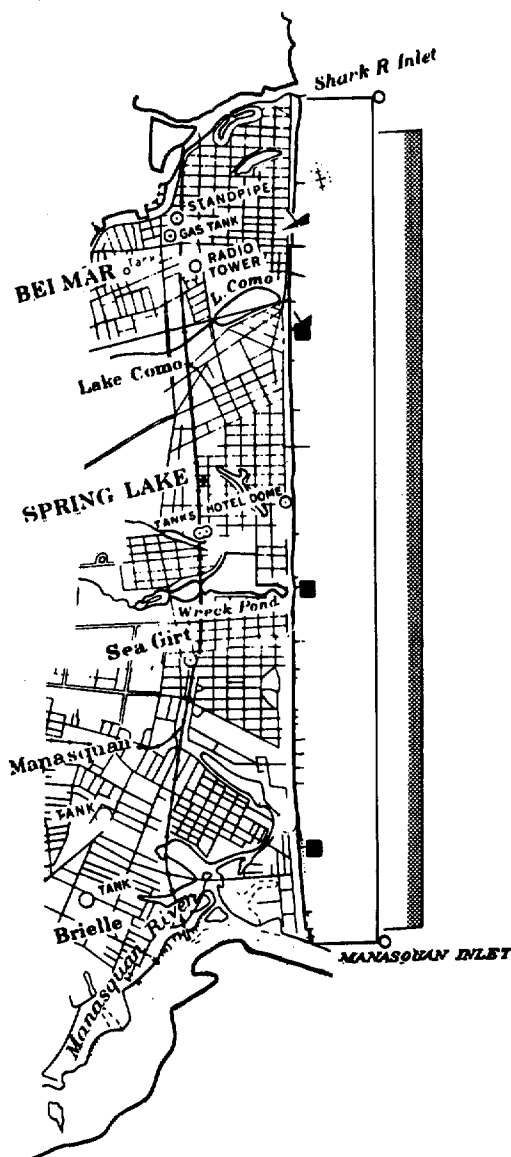
(4) The Plan For Reach 4 — Shark River Inlet to Manasquan Inlet. The priority analysis has shown that none of the reach-level engineering alternatives evaluated for Reach 4 are economically justifiable. Therefore, none of these engineering plans are recommended on a priority basis. It is, however, recommended that a limited program of maintenance and/or modification of shore protection structures be adopted to mitigate local erosion problems on an as needed basis. Local projects are conditionally acceptable under this plan if they can be shown to be cost effective in a case-by-case evaluation and that they will not create adverse effects in adjacent shore areas.

Modification of selected high profile groins, generally located at town limits, should be considered to mitigate local beach starvation effects. Consideration of sand bypassing across Manasquan Inlet is also a possibility. However, this would provide only limited relief of beach erosion at the southern end of the reach. There is insufficient sand available for bypassing to adequately supply the entire reach. Consideration would also have to be given to potential adverse effects to beaches south of the inlet. The Corps of Engineers, Philadelphia District is currently completing a detailed study of inlet bypassing alternatives at Manasquan Inlet. The results of that study were not available for inclusion in the Master Plan document.

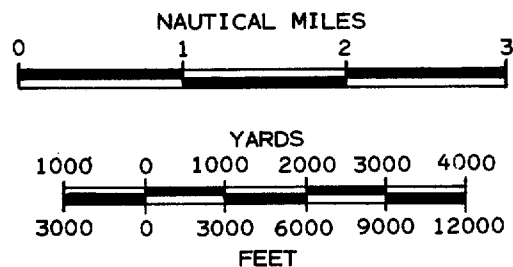
Of the alternative engineering plans evaluated for Reach 4, the most cost beneficial plan was the Recreational Development alternative. This alternative has a benefit cost ratio of 0.70 and an estimated total present worth cost of about \$13.2 million. The major components of the cost estimate for this alternative are provided in Table II.B-9. The alternative is illustrated schematically on Figure II.B-6.

TABLE II.B-9  
COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 4 - SHARK RIVER INLET TO MANASQUAN INLET

<u>Cost Components</u>	<u>Estimated Initial Costs</u>	<u>Estimated Present Worth Cost Totals</u>
<u>Beach Nourishment</u>		
o 975,000 cu. yd. at 5-year intervals to maintain existing beach widths		\$ 9,416,000
<u>Structural Modification</u>		
o Notching or lowering of 3 groins	\$ 150,000	150,000
<u>Initial Structural Maintenance</u>		
o Repair to 23 groins	3,424,000	3,424,000
<u>Maintenance of Existing Functional Structure</u>		
o 28 groins		174,000
<u>TOTALS</u>	<u>\$ 3,574,000</u>	<u>\$ 13,164,000</u>



## REACH 4 - SHARK RIVER INLET TO MANASQUAN INLET

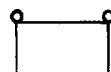


### RECOMMENDED PLAN

MAINTENANCE AND/OR MODIFICATION OF  
EXISTING FUNCTIONAL STRUCTURES ON  
AN AS NEEDED, CASE-BY-CASE BASIS

### MOST COST BENEFICIAL REACH ALTERNATIVE

#### RECREATIONAL DEVELOPMENT



MAINTENANCE OF THE EXISTING  
FUNCTIONAL STRUCTURES



PERIODIC BEACH NOURISHMENT



GROIN MODIFICATION

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The present available beach area in Reach 4, if maintained, will meet the projected daily recreational beach use demands throughout the project life. Therefore, no initial beach fill would be required for this plan. The Recreational Development program includes beach nourishment at 5-year intervals from offshore sources to maintain the existing beach widths as required. The plan also calls for modification (i.e., notching or lowering) of three groins (located at the borough line of Sea Girt and Spring Lake (Brown Avenue), and at the northern end of Manasquan (south of Stockton Lake)), to relieve sand starvation effects on adjacent sand starved beaches. The plan provides for initial repair and periodic maintenance of existing functional groins.

The recommended minimum program of structural maintenance and/or modification on an as needed basis would be consistent with the corresponding components of the Recreational Development alternative for Reach 4.

(5) The Plan For Reach 5 — Manasquan Inlet to Mantoloking. The priority analysis has shown that none of the reach-level engineering alternatives evaluated for Reach 5 are economically justifiable. Therefore, none of these plans are recommended on a priority basis. It is, however, recommended that a program of local maintenance and/or modification of shore protection structures and dune maintenance be adopted to mitigate local erosion problems. Local projects are conditionally acceptable under this plan if they will not adversely affect adjacent shore areas and can be shown to be economically feasible in a case-by-case evaluation.

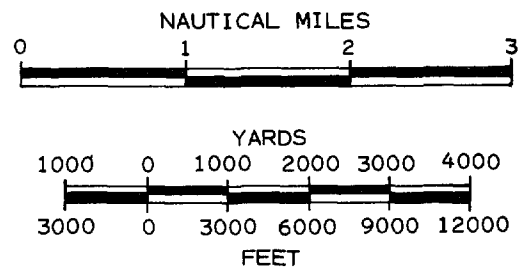
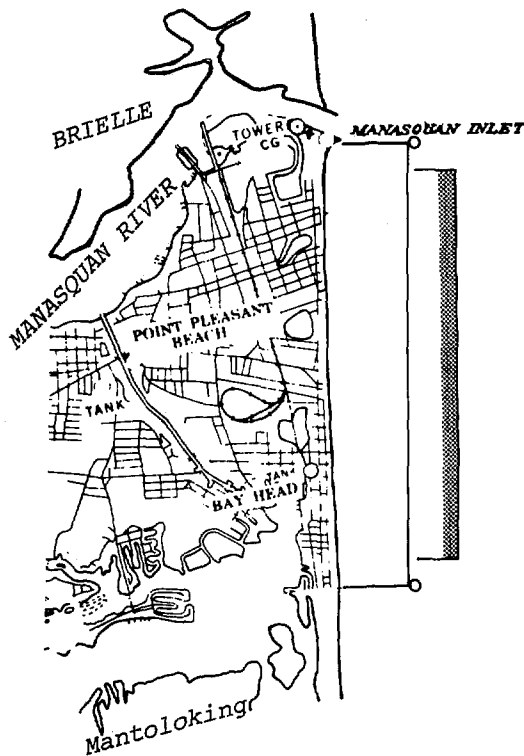
The Recreational Development program was found to be the most cost beneficial of the alternative reach engineering plans evaluated for Reach 5. This alternative has an estimated total present worth cost of \$12.4 million; however, it only has a benefit/cost ratio of 0.63.

For Reach 5, the existing beach capacity, if maintained through periodic renourishment, will satisfy projected daily recreational beach use demand throughout the planning period. Therefore, no initial beach fill would be required under the Recreational Development plan. Periodic renourishment from offshore sand sources is recommended at 10-year intervals under the plan to maintain the existing beach widths as required. The Recreational Development alternative also includes initial structural repairs to two groins and placement of dune grass and sand fencing for dune maintenance. Periodic maintenance of existing functional groins and sand fencing are also provided. The components of the cost estimate for the Recreational Development plan are summarized in Figure II.B-7 and on Table II.B-10.

The minimum program of structural maintenance and/or modifications recommended for Reach 5 would be consistent with the maintenance component of the Recreational Development alternative.



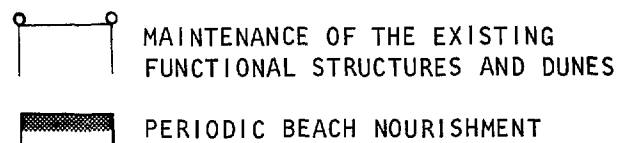
## REACH 5 - MANASQUAN INLET TO MANTOLOKING



### RECOMMENDED PLAN

MAINTENANCE AND/OR MODIFICATION OF  
EXISTING FUNCTIONAL STRUCTURES ON  
AN AS NEEDED, CASE-BY-CASE BASIS

### MOST COST BENEFICIAL REACH ALTERNATIVE RECREATIONAL DEVELOPMENT



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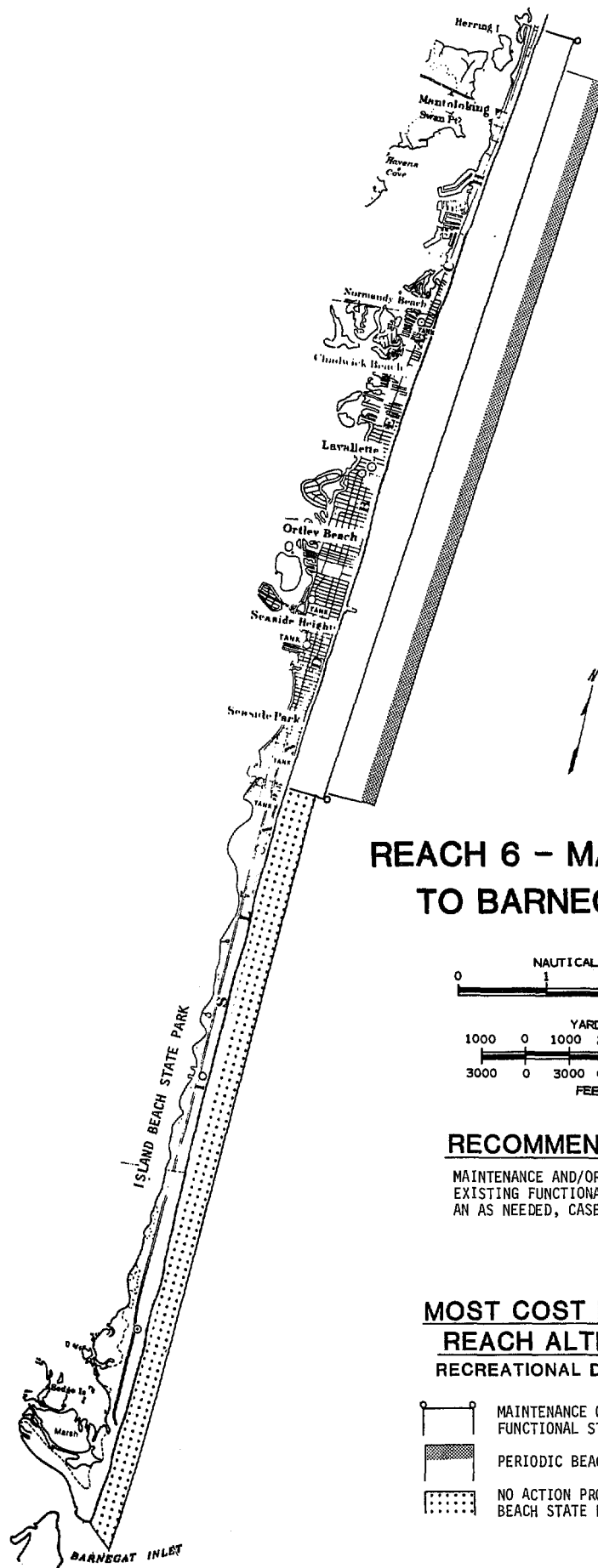
TABLE II.B-10

COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 5 - MANASQUAN INLET TO MANTOLOKING

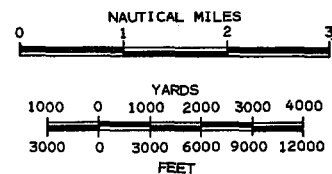
Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
<u>Beach Nourishment</u>		
o 962,000 cu. yd. at 10-year intervals to maintain existing beach widths		\$ 3,669,000
<u>Initial Structural Maintenance</u>		
o Repair to 2 groins	490,000	490,000
<u>Maintenance of Existing Functional Structures</u>		
o 6 groins		37,000
<u>Dune Maintenance</u>		
o Placement of dune grass (5 acres) and Sand Fencing (4000 L.F.), and replacement of sand fencing at 3-year intervals	38,000	75,000
<u>TOTALS</u>	<u>\$ 528,000</u>	<u>\$ 4,271,000</u>

(6) The Plan For Reach 6 — Mantoloking to Barnegat Inlet. The priority analysis has shown that none of the reach-level engineering alternatives evaluated for Reach 6 are economically justifiable. Therefore, none of the reach level plans are recommended on a priority basis. It is, however, recommended that a limited program of maintenance and/or modification of shore protection structures be adopted to mitigate local erosion problems. Local projects are conditionally acceptable under this plan if they can be shown to adequately address the needs of the area, they will not result in adverse effects in adjacent shore areas, and can be shown to be economically feasible in case-by-case evaluations. No action is proposed for Island Beach State Park at the southern half of the reach (see Figure II.B-8).

In the alternative analysis for Reach 6, the Recreational Development program was found to be the most cost beneficial of the reach engineering alternatives evaluated. The estimated total present worth cost for this alternative is \$7.8 million; the benefit/cost ratio is 0.38. Since the existing beach area, if maintained through periodic renourishment, will satisfy the projected recreational beach demand during the 50-year planning period, no initial beach fill would be necessary under the Recreational Development alternative. Beach nourishment from offshore sand sources is provided at approximately 7-year intervals to maintain existing beaches in Reach 6 as required. The plan also allows for initial repairs to two groins at Lavallette, regular maintenance for the existing functional groin field in Lavallette, and dune maintenance through the planting of 20 acres of dune grass and placement and subsequent



## REACH 6 - MANTOLOKING TO BARNEGAT INLET



### RECOMMENDED PLAN

MAINTENANCE AND/OR MODIFICATION OF  
EXISTING FUNCTIONAL STRUCTURES ON  
AN AS NEEDED, CASE-BY-CASE BASIS

### MOST COST BENEFICIAL REACH ALTERNATIVE RECREATIONAL DEVELOPMENT

- MAINTENANCE OF DUNES AND EXISTING  
FUNCTIONAL STRUCTURES
- PERIODIC BEACH NOURISHMENT
- NO ACTION PROPOSED FOR ISLAND  
BEACH STATE PARK

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maintenance of about 19,600 linear feet of sand fence. Emergency repair to the beach berm is also recommended after the occurrence of significant storm damage. Estimated costs for the major components of the Recreational Development alternative are summarized in Table II.B-11.

The recommended limited program of maintenance on a case-by-case basis for Reach 6 would be consistent with the Recreational Development plan since it provides for the maintenance of existing structures called for in that plan.

TABLE II.B-11

COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 6 - MANTOLOKING TO BARNEGAT INLET

Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
<u>Beach Nourishment</u>		
o 1,138,000 cu. yd. at 7-year intervals to maintain existing beach widths		\$ 6,926,000
<u>Initial Structural Maintenance</u>		
o Repair to 2 groins at Lavallette	\$ 549,000	549,000
<u>Maintenance of Existing Functional Structures</u>		
o Lavallette - 9 groins		56,000
<u>Dune Maintenance</u>		
o Placement of dune grass (20 acres) and sand fencing (19,600 L.F.) and replacement of sand fencing at 3-year intervals	159,000	339,000
<u>TOTALS</u>	<u>\$ 708,000</u>	<u>\$ 7,870,000</u>

(7) The Plan For Reach 7 - Long Beach Island. It is recommended that the Recreational Development alternative be implemented in this reach. This program is nominally cost beneficial on its own merits (B/C ratio of 0.96). However, the plan satisfies the maintenance requirement which the State and local governments accepted at the completion of the Federal shore protection project on Long Beach Island. The estimated total present worth cost of the alternative is \$11.3 million.

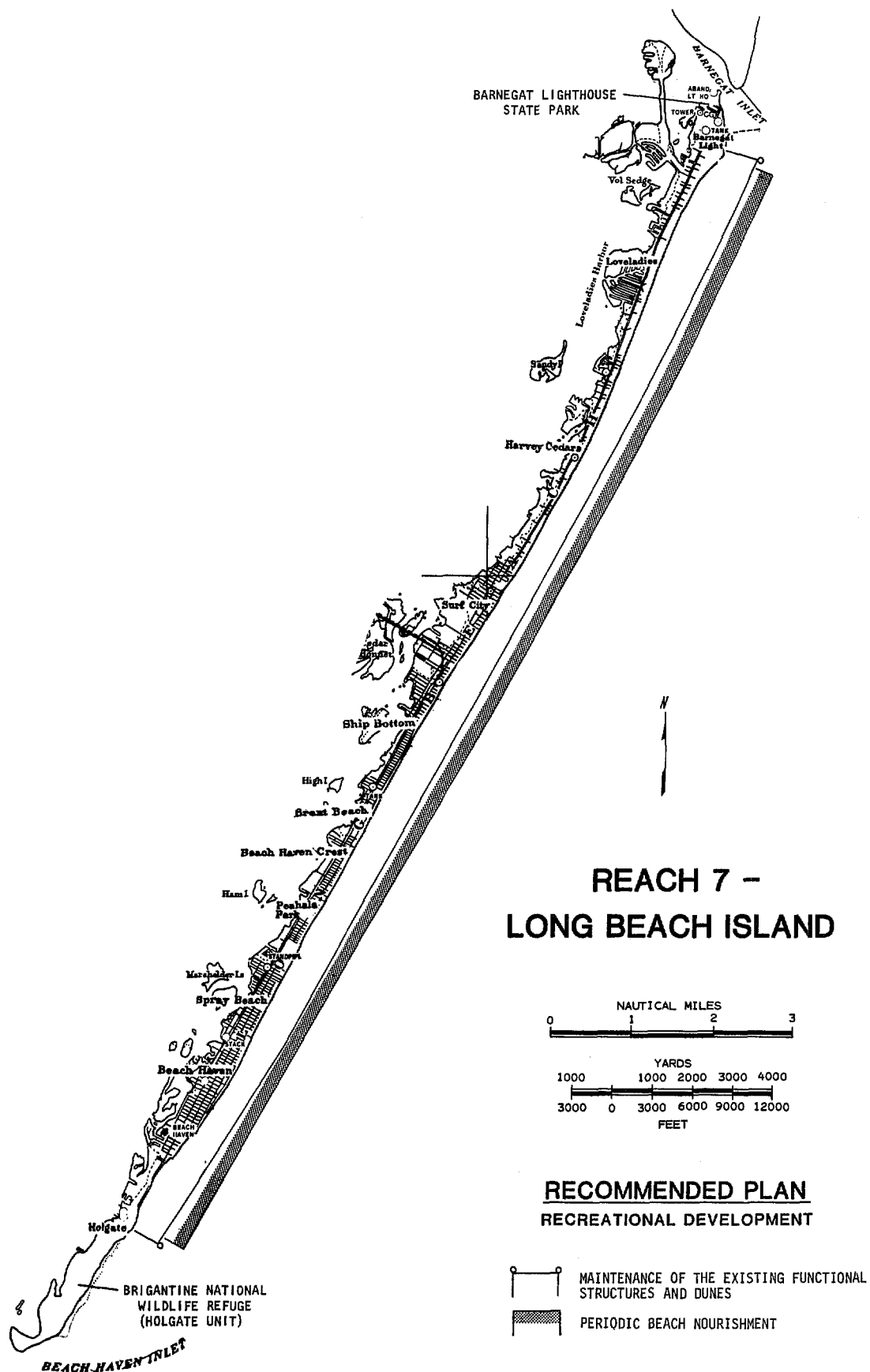
Almost all of Long Beach Island shoreline is ungranted. Public access and convenience features are also dispersed over the island so that no portion of the island is favored over another for the purpose of recreational development. The Recreational Development plan provides for maintenance of a recreational beach along the entire developed length of the island (Holgate unit of Brigantine Wildlife Refuge not included). The existing beach, with the provision of periodic beach nourishment from offshore sand sources, satisfies the projected recreational beach user demand for the 50-year planning period. Considering carrying capacity limitation estimates for Long Beach Island, only periodic beach maintenance is required to satisfy the estimated demands through the year 2025. The beach demand estimates and design capacities (in beach user days) and pertinent design beach width information for the recommended plan are provided in Table II.B-12. The major components of this alternative plan are shown schematically on Figure II.B-9.

TABLE II.B-12

REACH 7 - LONG BEACH ISLAND RECREATIONAL DEVELOPMENT PLAN  
(Beach User Days (in thousands) And Design Beach Widths  
Are Shown For Selected Years)

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
Peak Day Daily Demand	260.3	297.0	333.7	370.4	407.5	425.4
Average Day Daily Demand	112.3	123.7	137.7	152.2	166.4	177.9
Daily Beach Capacity Without Plan	364.2	328.2	292.2	256.2	220.2	184.2
Daily Beach Capacity With Plan	364.2	364.2	364.2	364.2	364.2	364.2
Average Beach Width With Plan	186 ft.	186 ft.	186 ft.	186 ft.	186 ft.	186 ft.
Total Additional Beach User Days Over 50-Year Period With Plan = 85,596.0						

Periodic beach nourishment from offshore sand sources is recommended as the means of maintaining the existing beach width. An estimated 1,019,000 cubic yards of fill would be required, at approximately 8-year intervals, to accomplish this objective. Structural maintenance under this alternative consists of initial repair to about 15 groins in the existing groin field. Planting of beach grass and installation of sand fencing are also recommended. Regular maintenance of the groins and the dune fencing would be provided throughout the economic life of the project.



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The initial cost of construction including the initial repair of functional structures, beach grass planting, and sand fence installation is \$3,638,000. The subsequent annual maintenance including periodic beach nourishment would average about \$701,000. The major components of this alternative plan are shown schematically in Figure II.B-9. Cost estimates of components and the total present worth cost of the recommended alternative are provided in Table II.B-13.

TABLE II.B-13

COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 7 - LONG BEACH ISLAND

Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
<u>Beach Nourishment</u>		
o 1,019,000 cu. yd. at 8-year intervals to maintain existing beach widths		\$ 6,172,000
<u>Initial Structural Repair</u>		
o 15 groins	\$ 2,214,000	2,214,000
<u>Maintenance of Dunes and Existing Functional Structures</u>		
o 98 existing groins		608,000
o Placement of about 220 acres of dune grass, 27,900 L.F. of sand fence and replacement of fence at 3-year intervals	1,424,000	2,327,000
<u>TOTALS</u>	<u>\$ 3,638,000</u>	<u>\$ 11,321,000</u>

(8) The Plan For Reach 8 - Pullen Island and Brigantine Island. No engineering plans are recommended for Pullen Island which is the last remaining undisturbed barrier island in New Jersey. Similarly, no action is proposed for the northern end of Brigantine which is occupied by the North Brigantine State Island Natural Area (see Figure II.B-10). For the remaining portion of Reach 8 the priority analysis indicates that none of the reach-level engineering alternatives evaluated for Reach 8 are economically justifiable. Therefore, none of these alternative engineering plans are recommended on a priority basis. It is, however, recommended that a limited program of maintenance of shore protection structures be adopted to mitigate local erosion problems. Local projects are conditionally acceptable under this plan if they do not create adverse effects on adjacent shore areas and can be shown to be economically feasible in a case-by-case evaluation.

The Recreational Development program was found to be the most cost beneficial of the alternative engineering plans evaluated for Brigantine Island. This alternative has an estimated total present worth cost of \$4.6 million, however, it only has a benefit/cost ratio of 0.17. A summary of the cost estimate for this plan is provided in Table II.B-14.



TABLE II.B-14

COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 8 - BRIGANTINE ISLAND

<u>Cost Components</u>	<u>Estimated Initial Costs</u>	<u>Estimated Present Worth Cost Totals</u>
<u>Beach Nourishment</u>		
o 962,000 cu. yd. at 10-year intervals to maintain existing beach widths		\$ 3,669,000
<u>Initial Structural Maintenance</u>		
o 5 groins and 360 L.F. of timber bulkheading	\$ 439,000	439,000
<u>Maintenance of Dunes and Existing Functional Structures</u>		
o 8 existing groins		50,000
o Timber bulkheading (4,200 L.F.)		23,000
o Placement of about 38 acres of dune grass, 22,100 L.F. sand fence and replacement of fencing on 3-year intervals	263,000	468,000
<u>TOTALS</u>	<u>\$ 702,000</u>	<u>\$ 4,649,000</u>

The existing beach area between North 14th Street and 42nd Street, if maintained through periodic renourishment, will satisfy the projected recreational demand during the 50-year planning period. However, improved access and parking would be needed to take full advantage of the area.

Under the Recreational Development plan no initial beach fill would be required. An estimated 762,000 cubic yards of fill from offshore sources is provided at approximately 10-year intervals to renourish and maintain the existing beach width. The plan also allows for initial repairs to 5 groins and approximately 360 linear feet of bulkhead to bring these structures up to a uniform level of integrity throughout the reach. Periodic maintenance to existing functional structures (8 groins and 4200 linear feet of bulkhead) is recommended to ensure their integrity during the economic life of the program. Dune maintenance through the planting of 38 acres of dune grass and placement of and subsequent replacement of 22,100 linear feet of sand fence is also provided.

The recommended limited program of structural maintenance on a case-by-case basis for Reach 8 would be consistent with the Recreational Development design plan since it provides for the maintenance of existing structures called for in that plan.

(9) The Plan For Reach 9 — Absecon Island. It is recommended that the Recreational Development alternative be implemented for the Absecon Island Reach. This program has a cost/benefit ratio of 1.44 and an estimated total present worth cost of \$29.4 million. The Recreational Development plan provides for an initial beach fill for a recreational beach with the dimensions illustrated schematically on Figure II.B-11. Estimated costs for the major components of the proposed plan are summarized in Table II.B-15.

TABLE II.B-15  
COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 9 — ABSECON ISLAND

Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
<u>Beach Fill</u>		
o Initial fill in Atlantic City to 400' berm width (520' beach width), tapered to a 150' berm width (270' beach width) at Jackson St., 150' berm width elsewhere	\$ 8,204,000	\$ 8,204,000
<u>Beach Nourishment</u>		
o 975,000 cu. yd. at 3-year intervals		17,192,000
<u>Initial Structural Maintenance</u>		
o Initial repairs to 7 groins, 1950 L.F. of timber bulkhead, and 1550 L.F. of concrete seawall (at Longport)	3,302,000	3,302,000
<u>Maintenance of Existing Functional Structures</u>		
o 7 existing groins		43,000
<u>TOTALS</u>	<u>\$ 11,506,000</u>	<u>\$ 28,741,000</u>



The Recreational Development plan evaluated in the Draft Shore Protection Master Plan provided for a wider initial beach and periodic beach expansions to accommodate projected recreational demand. Since the original design demand and beach width values for Absecon Island were considered to be anomalous as compared to other southern barrier island reaches, the Recreational Development beach design dimensions were reduced to minimize potential adverse impacts on the Absecon Inlet area. Under the modified plan, no periodic beach expansions are proposed after the proposed initial beach fill. As in the original plan, periodic beach nourishment, involving about 975,000 cubic yards of sand at 3-year intervals would be used to maintain the recreational beach throughout the economic life of the program. The beach demand estimates and capacity (in beach user days) of the design recreational beach are provided in Table II.B-16.

TABLE II.B-16

ABSECON ISLAND RECREATIONAL DEVELOPMENT PLAN  
(Beach User Days (in thousands) Are Shown For Selected Years)

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
Peak Day Daily Demand	375.5	427.2	478.9	530.6	582.3	634.0
Average Day Daily Demand	263.2	299.4	335.6	371.9	408.1	444.4
Daily Beach Capacity Without Plan	166.2	145.5	124.8	104.1	83.4	62.7
Daily Beach Capacity With Plan	298.1	298.1	298.1	298.1	298.1	298.1

Total Additional Beach User Days  
Over 50-Year Period With Plan = 408,000

Structural maintenance under the proposed alternative includes initial repairs to 7 groins, approximately 1950 linear feet of bulkhead and 1550 linear feet of concrete seawall (in Longport). Regular maintenance of existing functional groins would also be provided throughout the 50-year planning period to ensure their functional integrity. The beach and structural maintenance provisions under the Recreational Development Plan for Reach 9 would also satisfy the conditions of assurances given by the State and Atlantic City to maintain the completed Federal shore protection project at Atlantic City.

As this document goes to press, the DEP has begun the Phase II - Individual Reach Design Planning for Reach 9. Components of this phase will include detailed engineering design plans for the reach, bid specifications, statements of compliance with this Shore Protection Master Plan and the Rules on Coastal Resource and Development Policies (NJDEP, DCR, June 1981). In addition, discussions have begun with the various municipal governments, specific permits, and statements of compliance.

(10) The Plan For Reach 10 — Peck Beach. It is recommended that the Recreational Development alternative be implemented for this reach. Public access and convenience features such as the boardwalk and nearshore parking facilities are concentrated along the northern portion of the island. In this section of the reach an initial recreational beach of 170 feet in total width would be developed between Morningside Road at Beach Boulevard to 21st Street using sand from offshore sources. At the southern end of the reach, the beach would be tapered to meet the existing beach which would be maintained for the remainder of the reach. Considering the carrying capacity limitations of the reach, the recreational beach development is planned to meet the demands at year 2010. Periodic expansion of the beach is planned at 10-year intervals to keep pace with the estimated growth in recreational demand. The last beach fill is planned at year 2010 for a total beach width of 360 feet. The beach demand estimates, design capacities (in beach user days), and pertinent design beach width information for the recommended plan are presented in Table II.B-17. The components of the cost estimate for the Recreational Development plan for Reach 10 are provided in Table II.B-18.

TABLE II.B-17

PECK BEACH RECREATIONAL DEVELOPMENT PLAN  
(Beach User Days (in thousands) And Design Beach Widths Are Shown For Selected Years)

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
Peak Day Daily Demand	103.4	117.6	131.9	146.1	146.1	146.1
Average Day Daily Demand	89.9	102.3	114.7	127.0	127.0	127.0
Daily Beach Capacity Without Plan	93.7	57.7	25.0	0	0	0
Daily Beach Capacity With Plan	103.4	116.7	130.0	143.3	143.3	143.3
Average Beach Width With Plan	170 ft.	223 ft.	286 ft.	360 ft.	360 ft.	360 ft.

Total Additional Beach User Days  
Over 50-Year Period With Plan = 318,179.0

The initial beach fill of 314,000 cubic yards would cost an estimated \$2.8 million. Because of the relatively small volume, this beach fill may have to be combined with other projects or with planned periodic nourishment for this reach in order to attract competitive bidding. Periodic nourishment for the entire reach is recommended in this alternative. This amounts to about 1,170,000 cubic yards at 5-year intervals from offshore sources. The beach would thus be maintained during the economic life of the project.

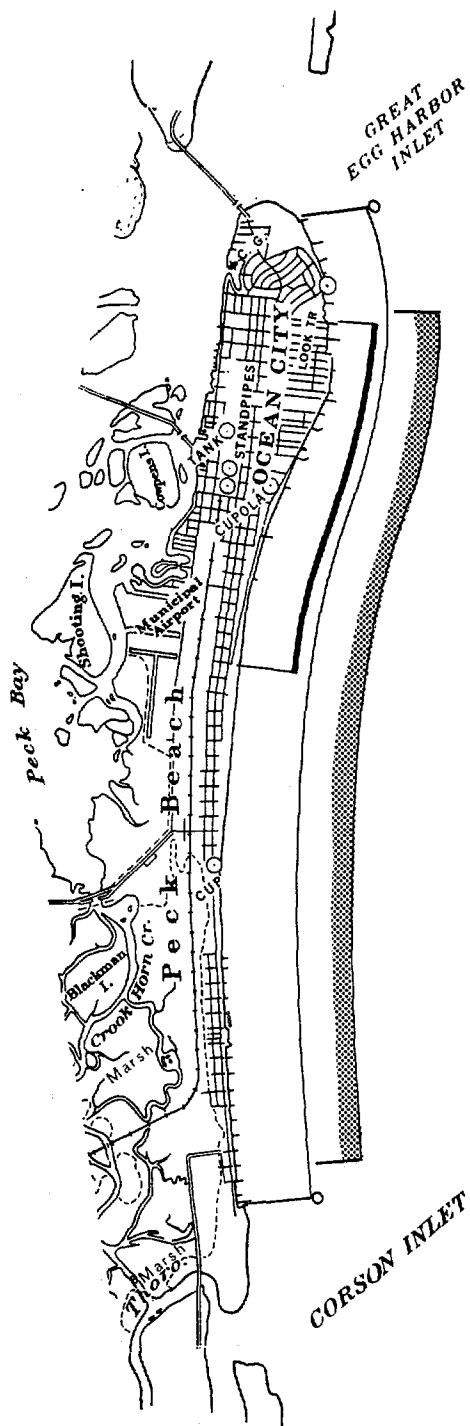
TABLE II.B-18

COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 10 - PECK BEACH

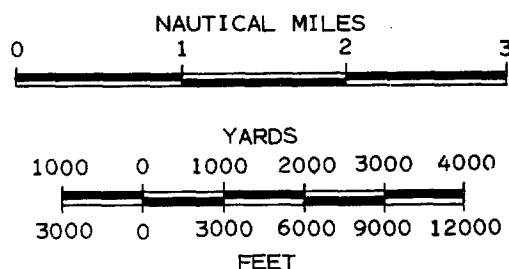
Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
<u>Beach Fill</u>		
o Initial fill at the northern end of island for a beach width of 170' (berm width approximately 8' at +10' MLW). In-place fill volume: 314,000 cu. yd.	\$ 2,794,000	\$ 2,794,000
o Periodic expansion in berm width in 10-year intervals (585,000 cu. yd. each expansion to year 2010) for a total beach width of 360' (berm width 180' at +10' MLW)		2,877,000
<u>Beach Nourishment</u>		
o 1,170,000 cu. yd. at 5-year intervals		10,895,000
<u>Initial Structure Maintenance</u>		
o Initial repairs to 3 groins and 1000' L.F. of timber bulkhead	433,000	433,000
<u>Maintenance of Dune and Existing Structures</u>		
o 20 groins and 12,000 L.F. of timber bulkhead		184,000
o Placement of about 32 acres of dune grass, 18,500 L.F. of sand fence and replacement of sand fence at 3-year intervals	220,000	390,000
<u>TOTALS</u>	<u>\$ 3,447,000</u>	<u>\$ 17,573,000</u>

Maintenance of functional structures would include initial repairs to 3 groins and about 1000 feet of timber bulkheading to bring these structures up to a uniform level of repair. Regular maintenance of existing shore protection structures is also provided to ensure their integrity during the 50-year planning period. Initial planting of 32 acres of dune grass and installation and maintenance of 18,500 linear feet of sand fencing is also included. The total estimated present worth cost of this plan is \$17.6 million. Its features are presented schematically on Figure II.B-12.

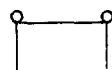

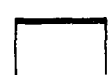
As this document goes to press, the DEP has begun the Phase II - Individual Reach Design Planning for Reach 10. Components of this phase will include detailed engineering design plans for the reach, bid specifications, and statements of compliance with this Shore Protection Master Plan and the Rules on Coastal Resource and Development Policies (NJDEP, DCR, June 1981). In addition, discussions have begun with the various municipal governments, specific permits, and statements of compliance.



## REACH 10 - GREAT EGG HARBOR INLET TO CORSON INLET (PECK BEACH)



### RECOMMENDED PLAN RECREATIONAL DEVELOPMENT

-  MAINTENANCE OF THE EXISTING  
FUNCTIONAL STRUCTURES AND DUNES
-  PERIODIC BEACH NOURISHMENT
-  INITIAL FILL FOR A BEACH WIDTH  
OF 170' (BERM WIDTH 8' AT +10 MLW)  
AND STEP INCREASE IN BEACH WIDTH  
TO 360 FEET BY 2010 (BERM WIDTH  
OF 180 FEET AT +10' MLW)

**DAMES & MOORE**

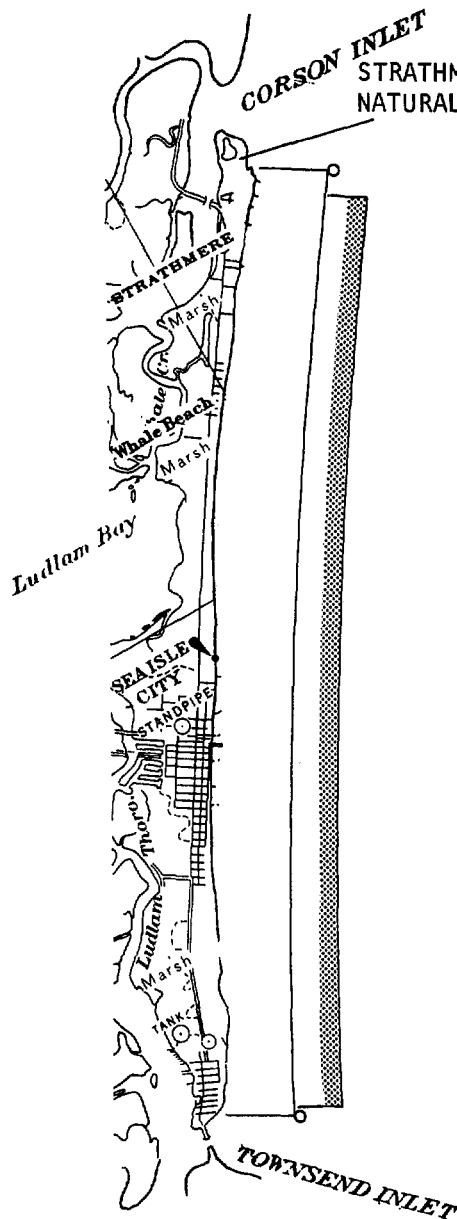
(11) The Plan For Reach 11 -- Ludlam Island. The priority analysis indicates that none of the these engineering alternatives evaluated for this reach are economically justifiable. Therefore, none of the reach-level engineering plans are recommended. It is, however, recommended that a program of maintenance and/or modification of shore protection structures be adopted on an as needed basis to mitigate local erosion problems. Local projects are conditionally acceptable under this plan if they will not adversely affect adjacent shore areas and they can be shown to be economically justified in case-by-case evaluations.

In the alternative analysis for Reach 11, the Recreational Development program was found to be the most cost beneficial of the reach engineering alternatives evaluated. The estimated total present worth cost for this program is \$20.7 million and the benefit/cost ratio is 0.88. The plan is illustrated schematically on Figure II.B-13.

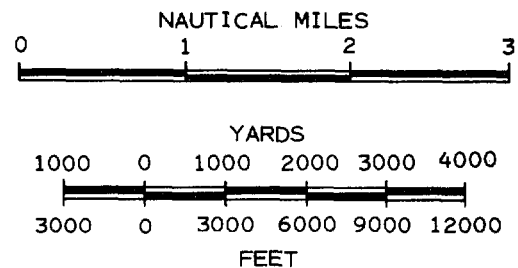
The Recreational Development plan calls for maintenance of a recreational beach along the entire reach. Since the present and projected beach use demand for Reach 11 would be satisfied if the existing beach area is maintained during the planning period, no initial beach fill would be necessary. Beach nourishment, involving approximately 1,170,000 cubic yards of sand from offshore sources at 3-year intervals, would be provided to maintain the existing beaches as required. The plan also allows for initial repairs to two groins and about 130 linear feet of timber bulkhead. Periodic maintenance of existing functional structures, including 18 groins and about 10,375 linear feet of bulkhead, is provided to ensure their integrity during the economic life of the project. Dune maintenance, including installation of about 12,800 linear feet of sand fence and 15 acres of dune vegetation, and sand fence replacement at 3-year intervals, would also be provided under the plan. The estimated costs for the major components of the Recreational Development plan are summarized in Table II.B-19.

The recommended limited program of case-by-case local maintenance for Reach 11 would be consistent with the Recreational Development plan since it provides the maintenance component called for under that plan.

As this document goes to press, the DEP has begun the Phase II - Individual Reach Design Planning for Reach 11. Components of this phase will include detailed engineering design plans for the reach, bid specifications, and statements of compliance with this Shore Protection Master Plan and the Rules on Coastal Resource and Development Policies (NJDEP, DCR, June 1981). In addition, discussions have begun with the various municipal governments, specific permits, and statements of compliance.



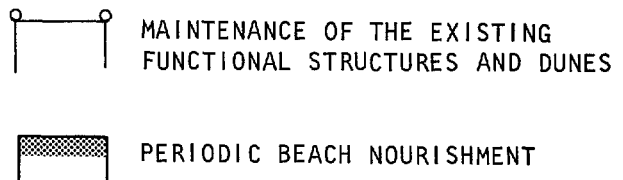
## REACH 11- CORSONS INLET TO TOWNSEND INLET (LUDLAM ISLAND)



### RECOMMENDED PLAN

MAINTENANCE OF EXISTING FUNCTIONAL  
STRUCTURES ON AN AS NEEDED, CASE-  
BY-CASE BASIS

### MOST COST BENEFICIAL REACH ALTERNATIVE RECREATIONAL DEVELOPMENT



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TABLE II.B-19

COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 11 - LUDLAM ISLAND (CORSONS INLET TO TOWNSEND INLET)

Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
<u>Beach Nourishment</u>		
o 1,170,000 cu. yd. at 3-year intervals to maintain existing beach widths		\$ 19,892,000
<u>Initial Structure Maintenance</u>		
o Repairs to 2 groins and about 130 feet of timber bulkhead	\$ 389,000	389,000
<u>Maintenance of Dunes and Existing Functional Structures</u>		
o 18 existing groins		117,000
o 10,375 L.F. of timber bulkhead		56,000
o Placement of about 15 acres of dune grass, 12,800 L.F. of sand fence and replacement of sand fence at 3-year intervals	112,000	233,000
<u>TOTALS</u>	<u>\$ 501,000</u>	<u>\$ 20,687,000</u>

(12) The Plan For Reach 12 - Seven Mile Beach. It is recommended that the Recreational Development alternative be implemented in this reach. This alternative has a benefit/cost ratio of 1.37 and an estimated total present worth cost of \$7.7 million.

A recreational beach is planned for the oceanfront beach. This alternative calls for beach fills along the reach segment starting in the vicinity of 25th Street in Avalon and extending to the terminal structure at 127th Street in Stone Harbor. No action is proposed at Stone Harbor Point, the undeveloped southern end of the reach. The beaches in this area would be maintained (nourished) via the southerly transport of sand from nourished beaches north of the terminal structure.

Consideration of reach carrying capacity limitations indicates that the recreational beach maintenance be planned to satisfy beach user demand through the year 2022. The beach recreational demand estimates, the design daily capacities, (in beach user days), and pertinent design beach width information are provided in Table II.B-20.

TABLE II.B-20

SEVEN MILE BEACH RECREATIONAL DEVELOPMENT PLAN  
(Beach User Days (in thousands) And Design Beach Widths Are Shown For Selected Years)

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
Peak Day Daily Demand	157.9	179.6	201.3	223.1	244.8	249.1
Average Day Daily Demand	90.3	102.7	115.1	127.4	139.8	142.4
Daily Beach Capacity Without Plan	131.5	108.9	86.3	63.7	41.1	18.5
Daily Beach Capacity With Plan	132.7	149.7	166.7	183.7	200.7	200.7
Average Beach Width With Plan	160 ft.	180 ft.	200 ft.	220 ft.	240 ft.	240 ft.

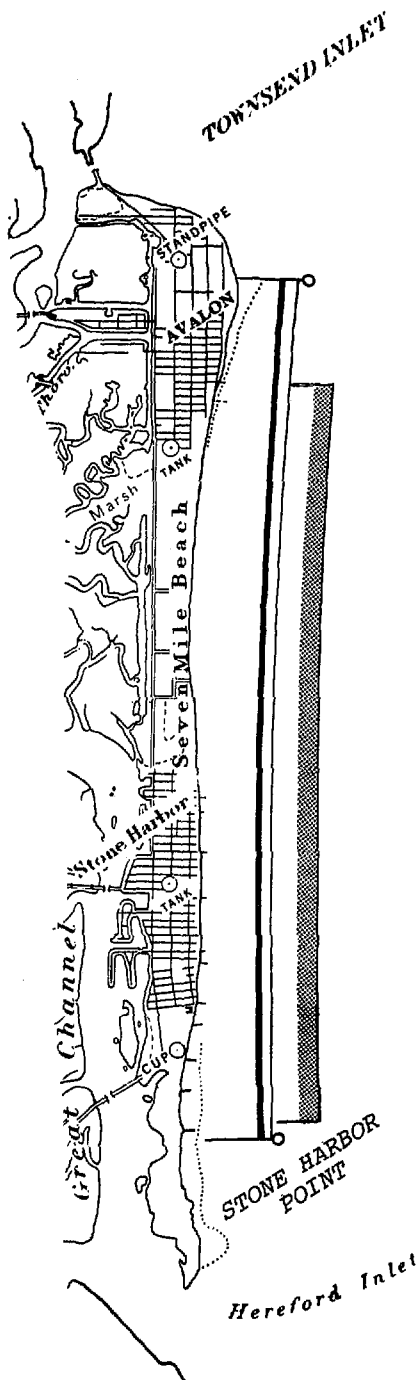
Total Additional Beach User Days  
Over 50-Year Period With Plan = 238,190.0

The present beach demand for Reach 12 is satisfied by the existing available beach area. Periodic expansion in beach width is recommended to accommodate the growth in beach use demand over the 50-year planning period. Periodic beach expansions would require placement of 544,000 cubic yard fills on the beach during each interval. The last beach fill, planned for year 2020, would provide adequate beach area to satisfy the projected design daily capacity at year 2022. It is estimated that the carrying capacity of the transportation systems servicing Seven Mile Beach would constrain the recreational demands at that time.

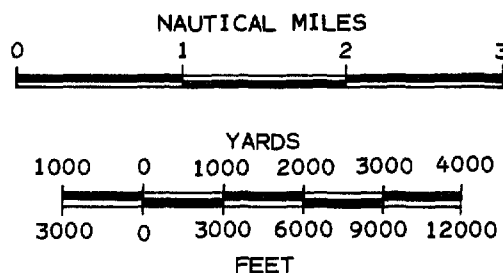
Periodic nourishment is recommended to maintain the beaches at their design widths. Nourishment from offshore sand sources would involve placing 1,118,000 cubic yards at 10-year intervals. Periodic nourishment and expansions can be scheduled concurrently to provide more attractive project quantities for contract bidding.

Maintenance items under this alternative include initial repairs to one groin and approximately 620 linear feet of timber bulkheading. Periodic maintenance of functional shore protection structures, including 10 groins, 12,600 linear feet of timber bulkheading, and 800 linear feet of stone revetment is also provided to ensure their integrity throughout the economic life of the project. Dune maintenance, in the form of planting beach grass and sand fence installation, is also recommended for this reach.

The total estimated present worth cost of the Recreational Development plan is \$7.7 million. The components of the plan are illustrated schematically on Figure II.B-14. A summary of the components of the cost estimate for the plan are provided in Table II.B-21.






## REACH 12-TOWNSEND INLET TO HEREFORD INLET (SEVEN MILE BEACH)



### RECOMMENDED PLAN

#### RECREATIONAL DEVELOPMENT

-  MAINTENANCE OF THE EXISTING FUNCTIONAL STRUCTURES AND DUNES
-  PERIODIC BEACH NOURISHMENT
-  STEP INCREASE IN BEACH WIDTH TO 240 FEET (60 FOOT BERM WIDTH AT ELEVATION +10' MLW) BY THE YEAR 2020

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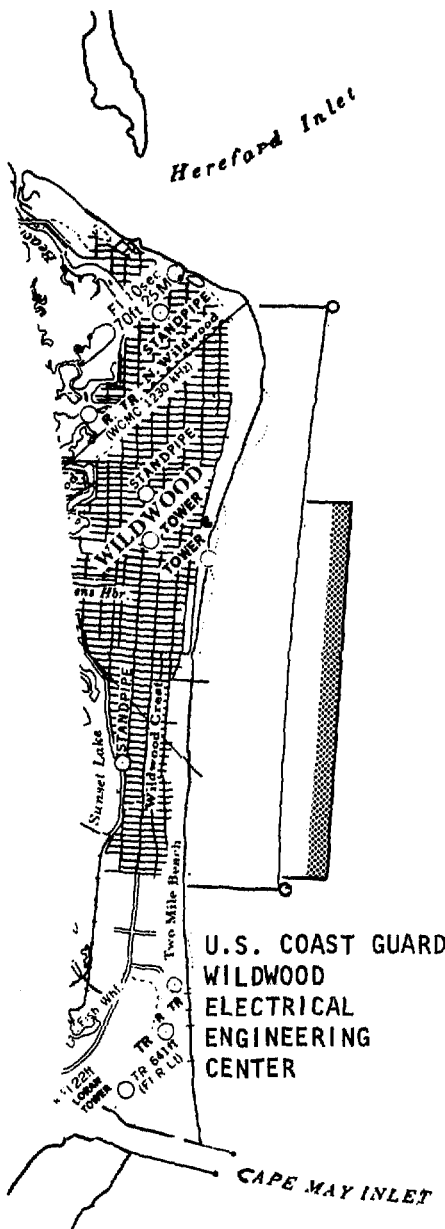
TABLE II.B-21

**COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 12 - SEVEN MILE BEACH (TOWNSENDS INLET TO HEREFORD INLET)**

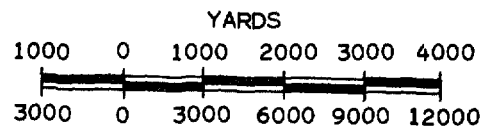
<u>Cost Components</u>	<u>Estimated Initial Costs</u>	<u>Estimated Present Worth Cost Totals</u>
<u><b>Beach Fill</b></u>		
o No initial fill is required		
o Periodic beach expansion (544, 000 cu. yd. in 10-year intervals) to a total beach width of 240' by 2020 (total berm width of 60' at +10' MLW)		\$ 2,689,000
<u><b>Beach Nourishment</b></u>		
o 1,118,000 cu. yd. at 10-year intervals		4,135,000
<u><b>Initial Structural Maintenance</b></u>		
o Repair of one groin and 620 L.F. of timber bulkhead	523,000	523,000
<u><b>Maintenance of Dunes and Existing Functional Structures</b></u>		
o 10 existing groins		62,000
o Placement of about 27 acres of dune grass, 13,300 L.F. of sand fence and replacement of sand fence at 3-year intervals	177,000	302,000
<u><b>TOTALS</b></u>	<u><b>\$ 700,000</b></u>	<u><b>\$ 7,711,000</b></u>

(13) The Plan For Reach 13 — Five Mile Beach. The priority analysis has shown that none of the reach-level engineering alternatives evaluated are economically justifiable. Therefore, none of these engineering plans are recommended on a priority basis. It is, however, recommended that a program of limited maintenance projects be adopted on an as needed basis. Local projects are conditionally acceptable under this plan if they will not adversely affect adjacent shore areas and they can be shown to be economically justifiable in case-by-case evaluations. As illustrated on Figure II.B-15, no action is proposed for the southern end of the reach, which is controlled by the U.S. Coast Guard.

The Recreational Development program was found to be the most cost-beneficial of the alternative reach engineering plans evaluated for Reach 13. This alternative has an estimated total present worth cost of \$973,000. However, the plan only has a benefit/cost ratio of 0.10. A summary of the cost estimate for the Recreational plan is provided in Table II.B-22.



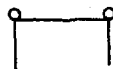
## REACH 13 - HEREFORD INLET TO CAPE MAY INLET (FIVE MILE BEACH)



### RECOMMENDED PLAN

MAINTENANCE OF EXISTING FUNCTIONAL  
STRUCTURES ON AN AS NEEDED, CASE-  
BY-CASE BASIS

### MOST COST BENEFICIAL REACH ALTERNATIVE RECREATIONAL DEVELOPMENT



MAINTENANCE OF THE EXISTING  
FUNCTIONAL STRUCTURES AND DUNES



BEACH NOURISHMENT AT THE END OF  
THE PLANNING PERIOD

**DAMES & MOORE**

FIGURE II.B-15

TABLE II.B-22

COST ESTIMATE SUMMARY  
RECREATIONAL DEVELOPMENT ALTERNATIVE  
REACH 13 - FIVE MILE BEACH (HEREFORD INLET TO CAPE MAY INLET)

Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
<u>Beach Nourishment</u>		
o 845,000 cu. yd. at the end of the 50-year planning period		\$ 62,000
<u>Initial Structural Maintenance</u>		
o Repairs to 900 L.F. of timber bulkhead	\$ 584,000	584,000
<u>Maintenance of Dune and Existing Structures</u>		
o 3,000 L.F. of timber bulkhead		16,000
o Placement of 24 acres of dune grass, 15,200 L.F. of sand fence and replacement of sand fence at 3-year intervals	168,000	311,000
<u>TOTALS</u>	<u>\$ 752,000</u>	<u>\$ 973,000</u>

For Five Mile Beach, the existing beach area is large enough to satisfy existing and projected demand until the year 2020. Therefore, no initial or periodic beach fill nourishment would be required for maintenance of the recreational beach. Beach loss rates and demand growth estimates indicate that beach nourishment may be required to maintain the beaches at the end of the 50-year planning period. It is estimated that selective filling of approximately 845,000 cubic yards from offshore sand sources would be adequate to maintain the beach width as required.

The plan allows for initial repair to approximately 900 linear feet of bulkhead to bring it up to a uniform level of repair. Subsequent periodic maintenance of 3000 linear feet of bulkhead is also provided to insure its integrity during the economic life of the project. For dune maintenance the plan calls for planting of 24 acres of dune grass, placement of about 15,200 linear feet of sand fencing, and replacement of sand fencing at 3-year intervals.

(14) The Plan For Reach 14 - Cape May Inlet to Cape May Point. The priority analysis has shown that none of the reach-level engineering alternatives evaluated for Reach 14 are economically justifiable. Therefore, none of these reach engineering plans are recommended on a priority basis. The engineering plan proposed by the Corps of Engineers (USACOE, Philadelphia District, 1980) will be adopted by the DEP for this reach. This plan, which is summarized schematically on Figure II.B-16, provides beach fill and nourishment, groin construction, and structural maintenance to mitigate the effects of sand starvation as a result of the construction of the Cape May Inlet jetties. The plan would be fully funded by the Federal government as mitigation



SOURCE: USACOE,  
PHILADELPHIA DISTRICT, 1980

of damages caused by the Federal navigation project at the inlet. However, the entire reach is not covered by the Corps plan. Only the most serious conditions along Cape May City and the Coast Guard area at Sewell Point have been treated. In addition to the tentative Corps plan, a program of local maintenance of shore protection structures is recommended on an as needed basis at Cape May Point. Such local structural projects are conditionally acceptable if they will not adversely affect adjacent shore areas and can be shown to be economically justified in case-by-case evaluations.

(15) The Plan For Reach 15 — Delaware Bay. It is recommended that a general program of maintenance of functional structures be followed in this reach, with local projects selected for implementation on a case-by-case basis. The evaluation will consider both the local needs to be served, the potential of adverse impacts on adjacent shore areas and natural resources, and the overall economic feasibility of these projects. Previous alternative evaluations by the Corps of Engineers have not developed specific plans which satisfy these criteria. The general plan provides the opportunity to implement and maintain cost justified structural and nonstructural shore protection works as needed.

(16) The Plan For Reach 16 — Delaware River. It is recommended that a program of construction and maintenance of shore parallel structures such as bulkheads and low-cost erosion control methods be followed to mitigate local erosion problems. Local projects will be selected for implementation on a case-by-case basis. In each case, the evaluation will consider both the local needs to be served, the potential for adverse physical and environmental impacts, and the economic feasibility of these projects.

c. Non-Reach Engineering Project Proposals

In the past, the DEP's Bureau of Coastal Engineering (previously the office of Shore Protection) made an annual determination of the shore protection needs for inlets, bays, backbays, and other tidal tributary waterways. Funding was based on the availability of financial and technical resources, as well as the urgency of the erosion problem.

Due to the diversity of physical processes along these shores, the reach concept of erosion control is not effective in these areas. Therefore, as discussed below, under the Shore Protection Master Plan, erosion control projects for these areas will be evaluated for implementation on a case-by-case, as needed basis with available funds. Evaluations will consider State coastal Management policies and objectives as well as economic feasibility.

(1) Inlet Shores. A general plan of inlet shore protection is proposed for evaluation and implementation on an as needed, case-by-case basis. Historically, erosion control methods for New Jersey coastal inlet shores have included construction of bulkheads, groins, revetments, and jetties, and beach fill programs. These types of projects are acceptable if they can be shown to be economically justifiable and will not cause adverse physical or environmental impacts on the inlet or adjacent shore areas.

No action is proposed for Beach Haven, Little Egg, and Brigantine, or Corson Inlets which will be left in their present natural condition. Maintenance of existing inlet shore protection structures, including jetties under State-law responsibility, will be considered on an as needed basis for Shark River, Absecon, Great Egg Harbor, Townsend, and Hereford Inlets. The structures on Manasquan, Barnegat, and Cape May Inlets are a Federal responsibility.

A detailed listing of inlet shore protection projects under consideration by the DEP is provided in Volume 2, Section VI.B.16.

(2) Bays, Backbays, and Tributary Waterway Shores. A general program of shore protection work using low cost structural and nonstructural techniques is recommended for bays, backbays, and tributary waterway shores to mitigate local erosion problems. Local projects are conditionally acceptable on a case-by-case basis if it can be shown that they are economically justifiable and will not result in adverse physical or environmental effects on adjacent shore areas.

### 3. Funding Options For Engineering Plans

The priority reach engineering projects and their related costs are provided in Table II.B-23. The table includes the initial project costs and subsequent annual costs for the first several years after implementation of each project, together with the 50-year project costs and average annual costs in 1980 dollars. This information will be used to evaluate the fiscal requirement of engineering program implementation.

The findings and assumptions related to the funding and implementation of engineering projects are summarized as follows:

- o At present, about \$15 million of the Beaches and Harbors Bond monies remains to cover the State's share of engineering projects costs;
- o The DEP intends to set aside about one third of available shore protection funds for implementation of non-reach engineering programs and emergency shore protection projects on the ocean shore and shores of rivers, bays, and backbay areas. Thus \$10 million is available for State cost sharing of priority reach-level projects and \$5 million is available for non-reach and emergency projects;
- o The recommended priority list of five reach projects (out of thirteen oceanfront reaches) calls for initial expenditures totalling \$25.5 million and an estimated average annual expenditure of \$4.3 million for the remainder of the 50-year project life. The cost of implementation of the most cost-beneficial reach projects for the remaining oceanfront reaches is \$34.5 million initially and would average about \$6.7 million annually for the remainder of the economic program life; and
- o Due to the present uncertainties associated with the willingness or ability of reach municipalities to participate in the shore protection program, it is not known whether this list of priority projects will remain intact. For present planning purposes, however, it is assumed that the priority list will remain as shown.

TABLE II.B-23

**ENGINEERING COSTS FOR PRIORITY REACHES**  
(thousands of 1980 dollars)

Reach/Project	Initial Cost <sup>(b)</sup>	Estimated Annual Costs <sup>(a)</sup>				50-Year Project Cost
		Year 1	Year 2	Year 3	Average <sup>(c)</sup>	
Peck Beach Recreational Development	\$ 3,447	\$ 32	\$ 32	\$ 32	\$ 1,289	\$ 67,897
Sandy Hook to Long Branch Maintenance	3,709	71	71	71	71	7,259
Absecon Island Recreational Development	11,506	4	4	5,145	1,572	90,106
Seven Mile Beach Recreational Development	700	17	17	17	640	32,700
Long Beach Island Recreational Development	3,638	138	138	138	701	38,688
Cumulative Totals	\$23,000	\$23,262	\$23,524	\$28,927	\$ 4,273	\$236,650

- (a) Annual costs for project maintenance during the first three years after program implementation are shown in columns labeled Year 1 to Year 3.
- (b) Initial capital costs of construction.
- (c) Average annual costs include all maintenance and improvement costs over the 50-year planning period. Initial construction costs are not included in the average annual costs.

In August 1981, DEP adjusted the municipal share of shore protection projects to be between 50% and 25%, depending upon whether the municipality is eligible for urban aid, whether an individual shore protection project is consistent with the respective Shore Protection Master Plan reach plan, whether it is undertaken by all municipalities within a reach, and whether adequate public access to beaches is provided by the municipality. This sliding scale has been requested by the State Legislature in the Appropriations Act (PL 1978 c.157). A more substantial reduction in the local cost share would require additional action by the Legislature. A bill now under consideration (A-1596) would change the current 50-50 cost sharing for shore protection programs to a 75-25 State-local share. This bill is strongly supported by the DEP.

Assuming no Federal participation and a 50-50 State-local municipality cost sharing:

- o The combined funds of \$20 million would be sufficient to cover the initial costs of four of the five priority oceanfront projects totalling \$19.4 million;
- o Approximately \$10 million in combined funds would be available for implementation of local, non-reach projects and emergency projects;
- o Although certain reach and non-reach projects could be initiated, monies are insufficient to completely cover the 50-year project cost for even the first priority project at Peck Beach; and
- o Additional future bond monies will be required to complete the priority projects and to continue funding of non-reach and emergency projects on a case-by-case basis.

Assuming a 75-25 State-local cost sharing for shore protection projects as proposed under A-1596, then:

- o The combined funds of \$15 million would not be sufficient to cover the initial costs of the first three projects on the priority list (total initial cost \$18.7 million);
- o Approximately \$7.5 million in combined funds would be available for implementation of local, non-reach projects and emergency projects;

Conversely, if there is Federal participation, other projects could move forward. However, because implementation of Federal cost-sharing participation is likely to take several years, if 75-25 percent cost sharing is enacted, initiation of all priority projects would not be possible until a second bond issue was passed.

As indicated in Table II.B-23, the average annual cost for implementing all five priority projects would be \$4.3 million (1980 dollars). Although some variability can be expected in these expenditures due to their periodic nature (e.g., periodic beach nourishment), the \$4.3 million amount can be used to estimate the additional bond monies required for plan implementation. If there is no Federal participation and 50-50 State-local cost sharing is assumed, a State funding requirement of about \$2.15 million per year, or an \$11 million (1980 dollars) bond issue every 5 years, would be required for maintenance during the economic life of the priority projects. If 75-25 State-local cost sharing is assumed, then State funding requirements for annual maintenance would be about \$3.2 million or \$16 million (1980 dollars) bond issue every 5 years.

The Department of Environmental Protection's annual Capital Improvement Plans since fiscal 1978 were reviewed to determine the funding of capital projects that utilized appropriations from existing bond issues, or which required the issuances of new bonds. The annual requests for such funds actually granted to DEP by the Commission on Capital Budgeting and Planning have ranged between \$76 million and \$93 million, and averaged \$90 million per fiscal year. This excludes fiscal 1979 during which DEP received an unusually low bond appropriation of \$18 million. Historically, requests for shore protection funds have averaged \$1 million per year. The passage of the 1977 Beaches and Harbors Bond Act raised the funding level to about \$4 million per year for 5 years. Thus, for a worst case situation where no Federal funding is available after depletion of the Bond funds, an annual funding level of about \$2.2 million would be required to maintain the priority projects. This appears feasible within the recent trends of DEP's total budget and expenditures for shore protection.

Federal participation could further improve the feasibility of funding the engineering plans. As discussed in detail in Volume 2, Section III.C.1.a, Federal funding for engineering projects may range up to 70 percent, with a 30 percent non-Federal share for publicly owned non-Federal parks and conservation areas, or a 50-50 cost sharing for publicly owned non-Federal shores other than parks and conservation areas. The degree of Federal participation for privately-owned but publicly-used shores varies according to the ratio of public benefits to total benefits. Assuming a 50-50 Federal non-Federal cost sharing of the priority list plans, and a 50-50 State-municipal cost sharing, the required bond monies for the State would be about \$5.5 million every 5 years. Federal cost sharing on the initial bond expenditures would equal about \$12 million and could be applied as the State's share of the first-two 5-year maintenance bonds, so that new bond monies would not be required until about year 15 of the program. Thus, the feasibility of implementing the engineering plans is significantly increased if Federal cost sharing is involved.

Another advantage of Federal participation relates to the sharing of costs to replace unanticipated major loss of the design beach during a severe storm event. The cost associated with the engineering alternative for a reach may not represent the final total cost necessary to maintain the design beach over a designated period. Significant loss to the design beach, for instance, may occur due to the effects of one or more severe erosion events. The high capital expenditure associated with initial project implementation could be lost in this case. Thus, it is possible that such events would result in 50-year costs which are three or four times those estimated, with no related increase in benefits.

It may be possible to share the costs of unanticipated losses with the Federal Government through Corps of Engineers programs, thus lessening the financial impact on the State. This could occur if the Corps of Engineers participated in the Master Plan engineering projects. Assuming initial Federal participation, the Corps may, through its emergency shore protection program, restore and repair an existing Federally authorized shore engineering project following major storm damage. Although the cost-sharing in this case is not explicitly stated, the maximum Federal cost-share for such emergency protection could be 100 percent. Non-Federal interests are usually required to bear the costs of land, easements, rights of way, operation and maintenance, and relocation of utilities. If the project cost exceeds \$1 million, Congressional approval is required prior to Federal assistance.

Federal cost participation in post-storm restoration may also occur even without initial Corps participation in the engineering project. As discussed in Volume 2, Section III.C.1.d, this can occur under the authority of the Disaster Relief Acts of 1970 and 1974, after a declaration of major disaster by the President. Such declarations are generally associated with storm events which are accompanied by high storm surge and resulting flooding damages. However, storm events which result in loss of the protective beaches, but which are not accompanied by widespread flooding damages, would not likely qualify as major disasters. In such cases, no Federal funding for restoring the storm losses would be available.

The limitation for Federal assistance, which stipulates that restoration of damaged beaches may not be extended beyond their historic shoreline (as determined from available survey data) unless required for protection of upland areas, could result in restored beaches which are not as wide as the design beaches provided under the Master Plan Program. In such cases, the total benefits anticipated for the 50-year period would not be realized.

Obviously then, from consideration of initial cost and emergency relief, the most appropriate course with regard to effective use of State funds is to solicit Federal participation in the Master Plan engineering program. There are two basic requirements for shore protection projects to be eligible for Federal assistance:

- o The project must demonstrate positive net benefits; and
- o Public ownership, public use, or substantial public benefits must be demonstrated.

The exact process of review and the additional Corps studies required to approve and quantify Federal cost sharing are not clear at present. It would appear that, in addition to review of the New Jersey Shore Protection Master Plan projects, detailed studies would be required as a part of the Corps pre-construction planning program, which includes the final engineering and design for the project, Congressional authorization for construction, and preparation of plans and specifications. These efforts could take 4 to 5 years to complete. The Corps' present shore protection program plans for the New Jersey oceanfront include flood protection, shore erosion control, and inlet stabilization including navigational improvements. The Master Plan includes shore erosion control only. However, the design considerations of the Master Plan are generally consistent with those of the Corps and the Master Plan emphasizes nonstructural approaches, as do the Corps plans. It appears that implementation of inlet stabilization may not be a requirement for Federal participation in this program.

Other potential factors which could contribute to delays in implementation of proposed engineering plans include:

- o Inability or reluctance of Federal, State, and local agencies to provide the necessary funds;
- o Requirements that public access be provided to beaches developed or improved with State or Federal funds; and
- o Inability to agree on State or Federal cost-sharing rules and maintenance responsibilities.

In a recent review of existing Federal policies related to a national coastal protection program, the former Heritage Conservation and Recreation Service in the U.S. Department of Interior (HCRS, January, 1980) proposed policy changes for programs related to disaster mitigation and recovery. The HCRS report suggested that the Corps of Engineers be encouraged to shift from engineering techniques toward cooperative land management and place added emphasis on the natural protective capabilities and ecological integrity of the wetlands, beaches, and dunes.

It is difficult to predict whether such policy changes will be implemented and, if implemented, what effect they may have on Federal participation in the engineering programs outlined in this Master Plan. If such policies are implemented, Corps approval of the engineering measures and Federal participation may be less likely. In light of these potential policy changes, the Master Plan may be a more acceptable plan since it does not include a structurally intense program such as inlet stabilization.

In addition to the potential funding problems discussed above, a number of additional problems may occur with respect to cost sharing between the State and local municipalities. These include the need for a determination of cost sharing between the municipalities within a reach, the ability of the municipalities to pay, and their willingness to participate given the requirement to provide public access and meet the other State requirements.

The following funding options will be adopted by the DEP:

- o The remaining \$15 million Beaches and Harbors Bond monies will be used to initiate the priority reach projects and selected non-reach projects over the next few years;
- o The DEP will request Federal participation and early evaluation of feasibility of participation and related studies;
- o Plans will be developed to seek additional bond monies for completion of the program;
- o If Federal participation occurs, the DEP will apply Federal monies for previously completed projects to reduce future bond requirements.

### C. LAND REGULATION

Shorefront land use regulation is primarily a local responsibility, and is exercised through zoning controls, sub-division approval, and construction review. The State's role in direct land use regulation is currently limited to the review of residential development with 25 or more dwelling units, and to certain types of commercial development under the Coastal Area Facility Review Act (CAFRA). The State also regulates industrial development under CAFRA, but of a type that is rarely undertaken in the areas addressed by this Plan. In addition, activities regulated under the Wetlands Act generally do not occur in ocean shorefront areas, and the Waterfront Development Law applies only to areas at or below mean high water at the shore. A bill now under consideration by the New Jersey Legislature would expand the State's regulatory role in the shorefront, but its passage is not being assumed for the purposes of this Master Plan (the bill is discussed below).

The most prevalent form of local shorefront control in New Jersey is an ordinance which establishes a fixed "construction line," seaward of which construction is prohibited. These ordinances are usually keyed to a fixed engineering line, which is usually determined with a reference to elevations above sea level or to the elevation of existing dunes. Ordinances of this type, many of which were developed following the storm of March 1962, are not intended so much to protect dune formations as to identify the point at which shorefront construction is no longer safe or economical. They are not "setback" ordinances in the ordinary sense, since they do not establish a setback footage.

The principal flaw in an ordinance of this type is that it fails to take natural processes into account. Construction lines are not periodically redelineated, and dune fields which were once entirely seaward of the building line often migrate landward until the building line runs along, or even seaward of, the dune crest. This leaves the municipality powerless to prevent construction on that portion of the dune landward of the line. Similarly, a dune may come into being on a vacant shorefront lot, but if the lot is landward of the building line, there is no basis for prohibiting its construction. Finally, such ordinances do not take erosion rates into account.

There are a number of land use measures which complement these construction setback ordinances, including ordinances which require shorefront property owners to maintain dunes on their property at a minimum elevation, often at their own cost.

Ordinances which are designated specifically to protect dunes, regardless of their location with respect to any line, are somewhat less prevalent in New Jersey, but they do exist. These ordinances define the term "dune," and then provide that no construction on or interference with the dune may be undertaken anywhere in the community, unless permitted by the municipality. Some ordinances define dunes as areas even where no dunes presently exist, so long as that area would be occupied by a dune if normal beach profile existed. Such ordinances are somewhat more effective than the "construction line" ordinances described above, although they clearly require diligence on the part of a municipality. They also raise technical and legal problems when it comes to defining a dune.

A variation on this type of ordinance is a measure that has been widely adopted in New Jersey, but whose viability has not yet been proven. In 1976, the Federal Emergency Management Agency (FEMA) modified the National Flood Insurance Program regulations by requiring municipalities which participate in the program

to establish minimum land use standards. The standards include minimum guidelines for protecting sand dunes, and are spelled out in published Federal regulations (24 CFR 1910.3(e)(8)). This provision requires that municipalities which encompass coastal high hazard areas, shall "prohibit man-made alteration to sand dunes which increase potential flood damage."

As part of its effort to implement this regulation, FEMA distributed a model ordinance which included the above quoted language. Almost every New Jersey shorefront community, in addition to submitting its existing ordinances in satisfaction of the minimum land use requirements, adopted the model ordinance as well. Almost every municipality, therefore, has a provision which prohibits man-made alterations to sand dunes which increase potential flood damage. At least one community, Ocean City, recently relied on this provision to prohibit the bulldozing of a sand dune and the construction of a house landward of its existing building line. This action has been upheld by the New Jersey Superior Court, Law Division, and is presently on appeal to the Appellate Division (*Williams vs Ocean City*, decision issued October 14, 1980).

A third method of shorefront regulation is to zone an area for beach, recreation and/or conservation purposes only, and to establish permitted uses in that zone which would prevent the destruction of sand dunes. This is a fairly common zoning measure in New Jersey, although the zone (variously referred to as a beach-dune or conservation-recreation zone) is generally limited to the actual beach area.

Finally, all shorefront communities have ordinances which establish certain construction performance standards for construction in or near beach and dune areas. Generally, these standards seek to insure the structural integrity of the building, rather than to avoid interference with natural beach processes.

All local shorefront land use measures are constrained by at least two factors: the intense level of existing development, and the legal problems posed by the "taking issue."

Existing development on almost all of New Jersey's barrier islands is of a degree that precludes a natural beach profile. A number of beaches support substantial primary dunes, but behind those dunes, in the area that would normally be occupied by secondary or tertiary dunes, stand homes. These structures not only interfere with natural beach processes, they also preclude the meaningful implementation of a rolling setback line, at least with respect to existing development. If the goal of such a setback is to keep development a safe distance from the sea, then a meaningful line can some day be established. But if the goal is to allow natural beach processes to take hold, or to regulate development prospectively, then the achievement of that goal will always be frustrated by the existing line of homes that would confront any migrating dunes. Of necessity therefore, even the most conservation oriented dune ordinances in New Jersey seek to protect and preserve a static dune line.

A second problem is the legal question of whether land use regulation so restricts the use of someone's land as to render it valueless, thereby constituting a "taking" without due process. A number of shorefront ordinances have successfully been challenged on this basis. Shorefront communities have responded to these challenges by inserting variance provisions in the ordinances which allow them to issue permits for construction seaward of a building line if it can be determined that construction will not jeopardize the public health, safety, or welfare.

As discussed at the beginning of this section, a bill now before the Legislature would give the State a direct role in the regulation of shorefront construction. A-2228, entitled the "Beach and Dune Protection Act," was introduced in November 1980. It requires every coastal municipality in Monmouth, Ocean, Atlantic, Cape May, Cumberland, and Middlesex (east of Cheesequake Creek) counties to prepare and adopt an ordinance for the regulation of land uses in beach and dune areas. The ordinances must comply with the bill's minimum standards for dune protection in order to be approved. DEP would be authorized to engage in direct regulation in those communities which fail to adopt such an ordinance. A similar bill, S-1636, was introduced in the State Senate in December 1980. These two bills were introduced after an initial more comprehensive legislative approach (A-1825) was withdrawn from the Assembly by its sponsor. That bill would have regulated construction in a wider area and prohibited reconstruction of buildings more than 50 percent destroyed by a coastal storm. (See Volume 2, Chapter XI.)

Thus, in accordance with its stated coastal management policies, the DEP is moving forward to develop land management tools for addressing the State's shoreline erosion problem.

#### D. LAND ACQUISITION

The acquisition of selected barrier island property can be one of the most cost-effective methods of shore protection, offering two simultaneous benefits: prevention of further development in an area that has proven to be prone to storm damage or to erosion, and facilitation of natural beach processes over a wider area, thereby affording greater protection to existing development.

There are, however, limited resources available for land acquisition. The State, through its Green Acres Administration, has since 1961 been assisting local and county governments to acquire open space tracts on a 50-50 matching basis. Green Acres funds are made available by bond issues, the most recent of which (1978) authorized the sale of \$200 million in bonds. These funds are allocated on the basis of the 1977 New Jersey State Wide Comprehensive Outdoor Recreation Plan (SCORP), which serves as the State's principal recreational policy document.

As of July 1981, the Green Acres Program had funded the acquisition of approximately 140 acres of shorefront property in Monmouth, Ocean, and Cape May counties. The purpose of this program has been to gain control of the dry beach area for recreational purposes, but some parcels (4.5 acres in Beach Haven Borough and 4.6 acres in Long Beach Township) extend landward to the first road, and thereby encompass small dune fields. Acquisition of such parcels offers derivative shore protection benefits by preventing development on dunes, although this is not a SCORP criteria.

Federally-funded acquisition programs are almost nonexistent. Section 1362 of the National Flood Insurance Act of 1968 provides for the purchase of heavily storm damaged, high hazard properties by the Federal government. In fiscal year 1980, \$5.4 million was appropriated for this voluntary program and was used for acquisition on Dauphin Island, Alabama and in Scituate, Massachusetts. However, it is unlikely that further funds will be available under Section 1362 in the future. The 97th Congress is considering legislation to create a national barrier island system, and to study the possible acquisition of units within that system. However, the legislation (H.R. 5981) is aimed at undeveloped barrier islands, and the only area in New Jersey for consideration within the system is Stone Harbor Point.

The Draft Shore Protection Master Plan (Dames & Moore, September 1980) examined possible acquisition strategies, and concluded that the purchase of property adjacent and parallel to the shore was not advisable (pg. VI-14). Instead, it recommended that barrier island tips, which are not already in Federal or State ownership, be given priority for post-storm acquisition.

The recommendation that areas parallel to the beach not be acquired was based in part on the assumption that a comprehensive state regulatory scheme encompassing that area would be in place. Since this is not the case, the State will, depending on the availability of funds, consider assisting local governments to acquire shorefront properties that have been heavily storm damaged, giving preference to shorefront areas maintained through engineering programs involving beach nourishment. Direct State land acquisition may also be considered, especially adjacent to existing DEP-managed parks and natural areas along the ocean. The purchase of such parcels would only be conducted on a post-storm basis since, as noted in the Draft Shore Protection Master Plan (pg. VI-13), the value of shorefront property is evenly divided between the value of the real estate and the value of the improvements thereon. Post-storm values, therefore, should be approximately one half of pre-storm values, assuming that the structures and other improvements on the site have been substantially or totally destroyed.

#### E. SUPPORTIVE FEDERAL PROGRAMS AND POLICIES

Numerous Federal programs and policies influence the degree and extent of shore protection, coastal development, and resource use. The most important programs include those administered by the U.S. Army Corps of Engineers and others dealing with National Flood Insurance and Federal Disaster Relief. A detailed discussion of each of these programs and the related policies are presented in Volume 2, Section III.D.

Other Federal programs relevant to coastal development and preservation include the following:

- o Environmental Impact Statement Review Process
- o Flood Plain Management and Wetlands Protection (Executive Orders 11988 and 11990)
- o National Park System
- o Soil Conservation
- o Fish and Wildlife
- o Air Quality
- o Wastewater Treatment Facilities Grants
- o Bridge and Highway Construction Programs and Permits
- o Federal Surplus Property
- o Interstate Land Sales
- o Economic Development Administration Grants
- o Urban Planning Assistance
- o Federal Home Mortgage Insurance
- o Mineral and Oil Exploration and Extraction
- o Land and Water Conservation Fund Grants

These programs are also discussed in detail in Volume 2, Section III.D.

New direction in Federal policies on shore protection have recently been taken as a result of the President's first (May 1977) and second (August 1979) Environmental Messages. The first message identified the unique aspects of the barrier islands of the Gulf and Atlantic, and called for a review of existing and conflicting Federal policies that affect these ecosystems, and directed the Secretary of Interior — in consultation with the Secretary of Commerce, the Council on Environmental Quality (CEQ), and State and local officials in coastal areas — to develop a plan to protect the barrier islands from unwise use and development. The President's second message outlined three initiatives aimed at achieving comprehensive and wise management of the coastal zone:

- o Reauthorization of the Coastal Zone Management Act for 5 more years at current levels;
- o Development of new amendments to the Act which would establish a national coastal protection policy; and
- o Conducting a systematic review, by the Secretary of Commerce, of Federal programs that significantly affect coastal resources.

The objective is to provide a basis for specific recommendations to improve Federal actions affecting the coastal zone and develop additional legislation needed to achieve the national coastal management goals.

In January 1980, the Heritage Conservation and Recreation Service (HCRS), in conjunction with the National Park Service (NPS), the Fish and Wildlife Service (FWS), and CEQ published a Draft Environmental Impact Statement (DEIS) on Alternative Policies for Protecting the Barrier Islands. The Department of Interior, Office of Coastal Zone Management, is presently reviewing Federal policies related to a national coastal protection program called for in the President's second environmental message. The HCRS Draft EIS made several significant conclusions:

- o Barrier islands need special recognition;
- o Review of existing Federal authorities related to barrier islands reveals the need for a clear Federal barrier island policy;
- o Information on which to base the formulation of barrier island policy needs to be made available to planners and other public and private officials;
- o Private actions must continue to play a valuable role in barrier island protection. Private commitment ranges from large national and regional conservation organizations to small groups and concerned citizens;
- o The roles of the states and localities are the key to the success or failure of any barrier island protection effort; and
- o Federal programs and authorities have, in many ways, encouraged development of barrier islands, resulting in potential problems of public health and safety, increasing costs, and loss of important public benefits provided by unspoiled barrier islands.

Pursuant to the President's 1979 message, the Department of Commerce undertook a systematic review of Federal programs affecting the coastal zone. This study, the "Federal Coastal Program Review," was completed in early 1981, and reached similar conclusions to those arrived at in the HCRS Draft EIS.

More recently, legislation has been introduced in the 97th Congress (H.R. 3252 and S. 1018) to prohibit Federal construction aid and flood insurance for new development on undeveloped barrier islands and undeveloped portions of developed islands. The only area in New Jersey affected by this bill is Stone Harbor Point, which is already subject to limitations on development under the conditions of an issued CAFRA permit.

The availability of Federally subsidized flood insurance is the most significant Federal program affecting developed barrier islands. Actuarial rates (i.e., rates that attempt to measure the actual risk of storm damage) have recently been raised for structures in coastal high hazard areas, but a program to individually review and rate all new structures has been abandoned.

Disaster relief is also a significant Federal action in the coastal context, but no firm policy on post-storm assistance has yet been articulated.

The DEP intends to support existing and evolving Federal programs which are consistent with the State coastal management policies and functional in providing upgraded coastal construction standards and relocation incentives and assistance for occupants of coastal high-hazard areas.

## CHAPTER III

### CONCLUSION AND SUBSEQUENT ACTIONS

The implementation of the Shore Protection Master Plan will require a number of accompanying actions and studies by various levels of government.

#### A. SCIENTIFIC AND ENGINEERING STUDIES

The conceptual engineering studies presented in the Master Plan are equivalent to the U.S. Army Corps of Engineers pre-construction engineering feasibility studies. As such, they relied on existing published data, air photos, and field observations. Two additional levels of effort will be required prior to construction of priority engineering projects. They include:

- o Pre-construction reach specific studies; and
- o Final design

These pre-construction reach specific design studies will require current beach profile and littoral drift rate and direction data to more accurately estimate the actual volumes of sand required for implementation of selected engineering projects. Selection and sampling of offshore sources of sand will be required to evaluate the suitability of the sand for application on the design beaches.

In addition, refinements in recreational demand estimates will be required for the priority recreational development projects. Beach counts and the development of a reasonable beach usage reporting scheme will also be required to provide, and periodically update, a data base for decision making on design beaches. Site specific evaluations of beach berm elevations and widths will also be required in the refinement of selected limited restoration or storm erosion protection designs to meet the design objective.

Finally, DEP's Bureau of Coastal Engineering will cooperate with municipal engineers, to prepare detailed designs and cost estimates for priority projects utilizing data collected during the pre-construction reach design studies. If substantial modifications of conceptual Master Plan design plans occur, the project specific engineering plans will be evaluated with respect to economic justification.

#### B. LEGISLATION

While this Shore Protection Master Plan is designed for use under existing laws, it could more effectively help lessen the loss of property and lives and government expenditures from coastal storms and beach migration if the New Jersey Legislature enacted a law further restricting development upon the ocean. The proposed Beach and Dune Protection Act (A-2228, 1980) would require a State-local partnership to regulate new development on beaches and dunes. Another similar approach would be to incorporate dune and erosion hazard areas into a regulatory format by using a methodology such as the one recommended in Volume 2, Section V.A.2.b. To be most effective in regulating the pattern of development in coastal high hazard areas, regulatory legislation would need to be in place prior to the next major storm.

### C. STATE-FEDERAL COORDINATION

Cost sharing for implementing the engineering alternatives will be sought through the Federal government. In particular, a determination of compatibility between selected engineering alternatives and U.S. Army Corps of Engineers funding criteria will be sought. This would enable the Federal government to provide up to half the total cost of an engineering reach plan in some instances. Priority engineering programs will be implemented even if Federal funds are not immediately forthcoming. If such funding becomes available in the future, the monies received will be applied retroactively to the engineering cost or they can be applied to cover additional engineering projects.

Funds for the land acquisition could also be sought at the Federal level, although the availability of funds is unlikely. These sources could include the Land and Water Conservation Fund Act of 1965, and Section 1362 of the National Flood Insurance Act of 1965, which provide grants to coastal states for land acquisition.

At the State level, additional funds will be obtained in one of two ways. One involves the passage of additional bond issues, similar to the 1977 Beaches and Harbors Bond Issue, to fund the implementation, and/or maintenance of the engineering alternatives. Second, additional Green Acres bond monies will be used for acquiring selected shorefront properties after storms.

### D. STATE - LOCAL COORDINATION

The determination of local government participation in the implementation of recommended shore protection projects will be based on three considerations:

- o Willingness to participate;
- o Ability to participate in cost sharing; and
- o State-local aid agreements.

Local governments must first be willing to participate in proposed engineering projects. Even where affected municipalities are willing to participate, their fiscal and debt characteristics must indicate that they are capable of raising the necessary funds for sharing in the costs of initial construction and subsequent maintenance of engineering projects. Such a determination would focus on the size of the local tax base and the current debt levels carried by the affected municipalities. The New Jersey Department of Community Affairs is capable of making assessments of the ability to participate.

State-local aid agreements will be required before priority reach engineering plans are finalized and implemented. The aid agreements will specify the cost sharing responsibility of each of the municipalities within a reach. State cost sharing will be contingent on local governments meeting certain minimum requirements with regard to information disclosure, beach use/demand monitoring, and whether it has acceptable policies and other management techniques for beach access, beach/dune protection, and erosion hazard areas. The specific requirements, to be negotiated at the time that the aid agreement is prepared, will be based on consistency between municipal policies and programs and the policies of the New Jersey Coastal Management Program.

Where reach municipalities are not willing to participate in proposed engineering programs given the conditions set forth in the State-local aid agreement, or where municipalities are not able to participate in cost sharing, the State will consider the next reach on the priority list — and so on. Where the priority reach project is a maintenance program — as is the case for Reach 2 (Sandy Hook to Long Branch) — local participation and project construction may be addressed for individual municipalities within a reach. This is because the recommended maintenance programs, as defined in Chapter II, Section B.1.c, can usually be implemented at a local level without significant adverse effects on adjacent reach segments.

State-sponsored continued public education and training programs — including public participation workshops, meetings, and hearings — will continue to keep the public informed and aware of evolving shoreline management programs and policies. The Shore Protection Master Plan is an important part of the DEP's ongoing public awareness program.

#### E. CONTINGENCY PLANNING

Contingency planning will be undertaken to allow for preparedness for (1) emergency mitigation of severe erosion events (2) emergency evacuation for barrier islands and other coastal hazard areas and (3) post-disaster cleanup and recovery. For each of the planning regions identified in Volume 2, Chapter IX, contingency plans will be further analyzed and refined during implementation of the proposed Master Plan programs.

Where shore communities do not already have emergency evacuation plans for hazard areas, at a minimum, they should identify probable evacuation routes, evacuation time requirements, and specify the role and responsibilities of local officials in dealing with evacuation emergencies, coordinating with State and Federal disaster assistance agencies, and the public. Local post-disaster cleanup and recovery plans should, at a minimum, consider contingencies for restoration of basic utilities (e.g., electric, gas and water), razing and clearing of destroyed structures, and programs for supply of food and shelter. As discussed in Volume 2, Section III.C.1.d., the Federal Emergency Management Agency administers the Federal Disaster Relief Program which encourages states to develop plans, programs, and capabilities for disaster preparedness, prevention, and mitigation. The Federal Government has granted funds for the preparation and periodic updating of such plans and programs.

#### F. MONITORING PROGRAMS AND STUDIES

Since engineering programs will not provide permanent solutions for the New Jersey's shoreline erosion problems, it is important that induced physical and environmental shoreline changes be monitored continuously against the background of widely variable natural changes. As discussed in Chapter I, Section C.3.b, natural changes are seasonal (e.g., calm-storm beach cycles), long term (e.g., sea level effects), as well as related to irregular external influences (e.g., violent storm effects). It is also important to recognize and monitor important legal, economic, social, and political trends related to the implementation of Master Plan engineering and land management programs.

The following studies and monitoring programs will be adopted to ensure that the Shore Protection Master Plan is being implemented and functioning as intended.

- o The shoreline migration rates will be monitored on a regular basis to maintain a consistent, uniform data base for future reference. This is best accomplished by utilizing annual or biannual aerial photographic coverage of the coast in conjunction with periodic beach profiling programs.
- o Utilizing erosion data obtained from the monitoring program above, and data obtained from longshore current measurements, littoral drift rates and directions will be periodically reassessed. This information is an important component in shore protection engineering design.
- o In reaches where engineering projects have been implemented, beach nourishment schedules and quantities will be periodically adjusted during the project life to accommodate shoreline migration trend fluctuations due to unanticipated variations in erosion and littoral drift rates.
- o Beach user attendance will be monitored and compared with forecasted recreational beach demand in those reaches where the recreational engineering alternatives are implemented. This will enable the engineering design plans to be adjusted during the project life to accommodate actual demand. It will also allow more accurate, short-term forecasts of annual maintenance and periodic improvement costs. In addition, it will help reduce inefficient resource allocation by avoiding the creation of unnecessarily large beaches.

The following studies and monitoring programs will also be considered in conjunction with implementation of engineering and land management plans.

- o Recording of property losses directly attributable to erosion impacts. This would allow an accurate assessment of the respective property protection benefits and costs that occur under the adoption of the selected plans, and any adjustment that might be required. Such recording could be done at the municipality level.
- o Monitoring of coastal land use changes induced by land management programs to assess development density changes within a regulatory zone as well as in remaining sections of the affected municipalities.
- o A survey of traffic conditions to determine how existing transportation links leading to shore areas are affecting access to the recreational beach on peak and average demand days.

With the publication of the Shore Protection Master Plan, the follow-up actions and studies discussed in previous sections of this chapter will be necessary for implementation of proposed engineering and land management programs. After implementation of the proposed programs, the State will be required to establish monitoring programs and studies to measure the effectiveness of the Master Plan and detect any induced direct or indirect physical, environmental, or socioeconomic effect. Monitoring will facilitate the implementation of corrective measures where they are found to be necessary.

Throughout the process of Master Plan implementation and monitoring, local and Federal participation and cooperation will be necessary if Plan objectives are to be met and if proposed programs are to function as intended.

#### **G. CONCLUSION**

The Shore Protection Master Plan is a major step in New Jersey's efforts to live and work, as well as to play, near the ocean. It attempts to match an analysis of current scientific knowledge, and a recognition of development patterns, social preferences, and economics with the legal and financial resources of government. The Plan will immediately be useful for shore protection decision-making, yet it is designed so that new information can be incorporated into it.

The Department of Environment Protection hopes that as people use this Plan, they will recognize the complex issues involved in shore protection and develop and suggest further improvements for New Jersey's shore protection program.

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